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# ENVIRONMENTAL TURBULENCE, ORGANIZATIONAL CAPABILITIES AND STRATEGIC RESPONSE:
## HOSPITAL STRATEGY IN AN ERA OF MANAGED CARE

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Abstract

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Managed care has had a profound influence on the demand for hospital services, as well as the agency relationship between hospitals and physicians. To succeed in this new environment hospitals must reconfigure the provision of services to meet these new demands and pressures. This thesis develops a model of the strategic interaction between hospitals and managed care organizations in which the level of services delivered by the hospital is a function of the contract form written by the HMO and the agency problem with physicians. The model suggests two possible strategic actions, capital adjustment and increases in monitoring, both of which may be effective in controlling the principal-agent problem between the physician and the hospital in the presence of managed care. Eleven three-stage least squared estimation systems are used to examine hospital changes in capacity, monitoring, HMO percentage and subsequent financial performance. The results suggest that hospital monitoring is an important determinant of the hospital's ability to serve HMO patients and that this translates into improved financial performance In addition there is evidence that hospitals are reducing the level of capacity in response to managed care. These hospital responses have the effect of controlling the agency costs and affecting the organization's financial performance. These results have important implications for hospital strategy under managed care.

# Table of Contents

**BACKGROUND & OVERVIEW** 1

**CHAPTER 1: INTRODUCTION** 8

Patients 9
The Physician 9
The Hospital 10
Health Maintenance Organizations (HMOs) 11
Agency Theory 16
Property Rights 16

**CHAPTER 2: LITERATURE REVIEW** 21

Agency in Health Care 24
Literature on Hospital Behavior 26

**CHAPTER 3: THEORETICAL MODEL** 31

Narrative Argument for Reduction in Level of Services 32
  *No Agency Problem Between Hospital and Physician* 33
  *The Presence of Agency Problems:* 36
3.2 Characterization of Physician Agency 40
  *The Hospital Problem* 40
  *The Physician Problem* 44
  *The Hospital-Physician Problem Together: Joint Production* 45
3.3 Hospital Choice of Capacity 47
  *Characteristics of the Model* 47
  *General Comments on the Model* 48
  *Implications* 66

**HYPOTHESES** 68

Hypotheses suggested by the model 68

**CHAPTER 4: RESEARCH DESIGN & ESTIMATION STRATEGY** 78

4.1 Data Source 80
4.2 Hospital Markets and Competition 81
  *4.2.a Definition of Hospital Markets* 81
  *4.2.b Definition of Hospital Competition* 84
4.3 Variables 85
  *4.3.a Study Variables* 85
  *4.3.b Market Control Variables* 90
4.4 Methods & Empirical Specification 91
  *4.4.a Three-Stage Least Squares* 91
  *4.4.b Partial Adjustment Model* 93
  *4.4.c The Empirical Model* 94
4.5 Hypotheses 99
  *Specific Discussion of Hypotheses on Study Variables* 101

**CHAPTER 5: EMPIRICAL RESULTS** 111

Discussion of Summary Statistics 111
  *Variation in the Sample over Time* 116
Correlation Table Discussion 118
Model Fit 118

Discussion of Model Results ....120
*Discussion of Hospital Sub-acute Bed % (Table 5.6 / Figure 5.1)....121*
*Discussion of Hospital Acute Care Bed % (Table 5.7 / Figure 5.2)....122*
*Discussion of Hospital Intensive Care Bed %, (Table 5.8 / Figure 5.3) ....124*
*Discussion of Total Beds (Table 5.9 / Figure 5.4)....125*
*Discussion of Total FTEs (Table 5.10 / Figure 5.5)....126*
*Discussion of Ambulatory Staff FTEs (Table 5.11 / Figure 5.6) ....127*
*Discussion of Purchase of Fixed Equipment (Table 5.12 / Figure 5.7) ....128*
*Discussion of Purchase of Moveable Equipment (Table 5.13 / Figure 5.8)....130*
*Discussion of Percent Capital Retired (Table 5.14 / Figure 5.9)....131*
*Discussion of Percent Capital Added (Table 5.15 / Figure 5.10) ....132*
*Discussion of Ratio of Capital Disposed to Added (Table 5.16 / Figure 5.11) ....134*
Discussion of Control Variables: ....134
Summary of findings across models in relation to hypotheses....138

**CHAPTER 6: DISCUSSION ....176**

Summary of Argument....176
Implications of Empirical Results....177
General Implications....179
Research Implications....184
*Health Care ....184*
*Broader Literature....186*
Managerial Implications ....186
Further Research Questions....187
*Theoretical Extensions ....187*
*Empirical extensions ....188*

**REFERENCES ....190**

## List of Tables

Table 1.1 Effect of HMOs on Incentives ........ 14
Table 4.1 Mean Hospital HMO % by Market and Time ........ 108
Table 4.2 Std. Deviation of Hospital HMO % by Market and Time ........ 109
Table 4.3: Hypothesized Signs on Study Variables........ 110
Table 5.1: Variable Means by Year ........ 143
Table 5.2a: Not For-Profit Change from 1989 - 1994 ........ 144
Table 5.2b: For- Profit Change from 1989 - 1994 ........ 144
Table 5.3: Variable Standard Deviations by Year ........ 145
Table 5.4: Correlation Table of Independent Variables........ 146
Table 5.5: System Fit and Cross Model Correlation ........ 147
Table 5.6 / Simultaneous Regression Model 1:........ 148
Table 5.7 / Simultaneous Regression Model 2:........ 150
Table 5.8 / Simultaneous Regression Model 3:........ 152
Table 5.9 / Simultaneous Regression Model 4:........ 154
Table 5.10 / Simultaneous Regression System 5:........ 156
Table 5.11 / Simultaneous Regression System 6:........ 158
Table 5.12 / Simultaneous Regression System 7:........ 160
Table 5.13 / Simultaneous Regression System 8:........ 162
Table 5.14 / Simultaneous Regression System 9:........ 164
Table 5.15 / Simultaneous Regression System 10:........ 166
Table 5.16 / Simultaneous Regression System 11:........ 168
Table 5.17: Hypothesized Signs on Study Variables........ 170
Table 5.18: Result Signs on Study Variables........ 171
Table 5.19: Confirmation of Study Hypotheses........ 172
Table 5.20: Signs on Control Variables ........ 173

## List of Figures

Figure 3.1:Change in Short-Run Average Cost Curves with HMO Penetration .........76
Figure 3.2: Diagrammatic Representation of Equation System ....................................77
Figure 5.1 Subacute Care % ......................................................................................... 149
Figure 5.2 Acute Care %............................................................................................. 151
Figure 5.3 Intensive Care %......................................................................................... 153
Figure 5.4 Total Licensed Beds .................................................................................... 155
Figure 5.5 Total FTEs ................................................................................................. 157
Figure 5.8 Ambulatory Staff FTEs ............................................................................... 159
Figure 5.9 Purchase of Fixed Equip. ............................................................................ 161
Figure 5.8 Purchase of Moveable Equip ...................................................................... 163
Figure 5.9 % Capital Retired ....................................................................................... 165
Figure 5.10 % Capital Added....................................................................................... 167
Figure 5.11 Ratio Capital Retired / Added ................................................................. 169
Figure 5.13: Summary of Supported Hypotheses ........................................................ 175

## Background & Overview

To understand the present configuration of health care providers, the evolution in strategies and the new contracting forms we see developing among health care providers, it is first necessary to understand the antecedents or environmental changes which gave rise to the present configuration. It was not too long ago, less than 50 years, that full indemnity insurance covering both physician and hospital services was far from the norm. Health insurance salesmen often traveled from door to door indemnifying the population. Patients who did have insurance were typically covered only for hospital services. This was consistent with the original intention of insurance: to indemnify the individual against low probability, high consequence events. Physician office visits were not so costly in real terms, and the patient usually paid for such services out of pocket. The patient was price-sensitive in securing care for physician services. Over time, however, the medical field evolved in terms of both its efficacy and its technological complexity. Technological advancements greatly improved not only the existing productivity of the physician –e.g.. antibiotics like penicillin -- but also the types of conditions which could be treated. Technology changed both the extensive margin for treatment – medical care could do more – and the production function for health – how it was produced. With these advancements, however, came increased costs and an increased need for insurance as encounters with the medical establishment at large became events of great financial consequence for the patient. This is not to suggest, however, that the returns to either the patient or society were not exceeded by the enormous benefit produced by technological advancement. The cost of care grew, which lead to greater proportions of the population being insured. The presence of insurance, particularly full insurance with small copays and deductibles, reduced the price sensitivity of the consumer. This further fueled the growth in the application of technology among providers as they were able to bill on a cost basis to insurers. There was little concern with efficiency, the marginal benefit of additional treatment, or technology compared with the cost.

Cost-based reimbursement continued as the norm until the early 1980s, when the introduction of prospective payment systems (PPS) by the Health Care Financing Administration (HCFA) heralded a new form of reimbursement. Providers of medical care, specifically hospitals, were reimbursed a flat rate per diagnosis group (DRG) regardless of the inputs employed in delivering care. This dramatically changed the incentives for the hospital to limit or reduce inputs subject to a lower bound on quality. Physicians, however, for the most part determined the production function for the hospital care. So while the hospital had an incentive to limit inputs per admission, the individuals controlling the production process derived little benefit from limiting inputs. Shortly thereafter came the growth of managed care organizations in various forms, which further transferred financial risk to providers in an effort to limit resource use and therefore costs.

The underlying theme is that the evolution of health care financing is a response to changes in the environment, namely the proliferation in the quantity and cost of medical technology and intensity. Seventy-five percent of the annual increase in health care expenditures has been attributed to changes in technology and intensity of treatment. Technology, however beneficial, has been a principal player in the dramatic increase we have seen in the cost of health care over the last 15 years. The growth of managed care may be interpreted as a revealed preference by society to constrain the rate of growth and may implicitly suggest that the marginal value of increases in technology and intensity outstrip the value of other goods or services which society must forgo.

In short, the growth in managed care may be viewed as an effort to constrain access to technology and intensive treatment that could not have been achieved in its absence. This thesis will demonstrate that the unchecked growth of technology and intensity led to the rise of managed care, and how managed care has effected changes in the activity of providers – namely hospitals – where a majority of the high technology care occurs and where costs have been escalating most rapidly. The objective of the health maintenance organization (HMO) with respect to providers is clear: to constrain the level and rate of growth in medical technology and those services which employ costly medical technology, thereby delivering a lower cost health care product. To that end, providers that configure their organizations in such a way as to reflect the demands of this increasingly dominant payer will be rewarded with increased market share and returns.

The basic contractual problem that managed care addresses is the inability of consumers (patients) to credibly contract with providers to place constraints on the use of technology and intense treatment in the production of health care services. When patients are in need of services, they desire all services that have any marginal benefit, particularly if they are fully insured. Patients are not in a position to demand the substitution of a less costly technology or less intensive treatment, due to a lack of information. Neither do they have the incentive, because they have insurance, which may or may not have implications for the quality of the health care produced. One does not often find an individual demanding, or an insurer or HMO financing, yesterday's technology at yesterday's prices. An individual physician or hospital has not had an incentive to limit the amount of technology delivered to a patient because the patient has been free to change providers to secure the level of service he/she demands. At the extreme, no patient is willing to forgo technology that will prolong his/her life, particularly if he/she does not fully bear the cost. This thesis asserts that the objective of managed care is to constrain the use of costly technology and treatment (which may or may not be high tech in nature). Providers that make investments (or dis-investments) consistent with perceived market trends will be rewarded. Operationally, this takes the form of hospitals choosing or adjusting their capacity in response to changes in market and hospital-specific HMO penetration. This affects the hospital's future demand and financial performance. The thesis develops a model of hospital behavior with respect to HMO contracting, develops hypotheses regarding hospital response to managed care and empirically tests these propositions on hospital data in the state of Florida for the period 1989-1994.

This thesis is organized as follows:

**Chapter 1** describes the historical evolution of the contracting relationships between patients, doctors, and hospitals. This will provide some background as to the incentives and decisions each party makes with respect to the other.

**Chapter 2** describes the literature on the subject of contracting between health care providers as well as the existing relevant theoretical literature on contracting. Agency theory and property rights are used as the underlying theoretical perspective to explain the changes in contracting between physicians, hospitals and insurers / HMOs. Alternative theories including industrial organization (IO) market power and efficiency-based rationales are discussed, and their implications for similar results are contrasted.

**Chapter 3** develops two models demonstrating the influence of agency costs on strategic behavior by hospitals. The first model elucidates the agency conflict that exists between hospitals and physicians regarding the desired level of hospital inputs delivered to the patient resulting from their separate fee schedules. The second model illustrates the strategic choice of investment (or dis-investment) by hospitals in response to managed care. This model has three stages. In the first stage the hospital makes a choice regarding the capacity and technology level it will supply in the care of patients. The choice of capacity is observable to the HMO and reflects the level of inputs that it can credibly commit to deliver to the patient. In the second stage, the HMO writes a contract with the hospital which is a function of its choice over capacity; the form of the contract is a function of the hospital's choice of capital investment. Finally, in the third stage, the hospital delivers a level of inputs to the patient as a function of the form of the HMO contract. Thus the model allows for the hospital to make a strategic investment in capacity that affects the form of contracting, need for monitoring and subsequent delivery of care. This section concludes with comparative static results regarding equilibrium levels of inputs supplied as a function of the hospital's choice of technology and HMO contracts. Hypotheses regarding hospitals' choice of capital investment, monitoring and subsequent performance as a function of organizational form follow from these comparative static results and logical extensions of the model.

**Chapter 4** describes the research design, models and variables to test the hypotheses. Specifically, a panel design is employed to examine changes in the capacity and monitoring in the hospital as a function of the managed care penetration the hospital provider faces in the marketplace. Changes in capacity are examined across a number of dimensions, including allocation of beds, size of hospital staff, and capital expenditures on new medical technology by the hospital.

**Chapter 5** presents the results from the empirical models of hospital response to managed care penetration in the marketplace.

**Chapter 6** draws implications from the results in Chapter 5 and suggests other actions which may be taken in response to the changing environment in which hospitals operate. The discussion further outlines the contributions made to both the economic literature on principal-agent (PA) contracting as well as the health care literature on the effect of managed care on provider behavior. With respect to theory, this thesis extends the research on multiple agent problems in which multiple agents must coordinate activities in production. The limitations of this research suggest implications for further research.

# Chapter 1: Introduction

Health care markets are in a state of disequilibrium as they move from a cost-based reimbursement (CBR) equilibrium to a capitated or at-risk state equilibrium in which the provider bears the financial risk for care delivered to the patient. This is fundamentally an adjustment by providers to a changing set of incentives. The CBR state placed little emphasis on providing care efficiently or evaluating the marginal net benefit of an additional unit of technology or intensity. In addition, the presence of insurance, and often full indemnification of financial risk to the patient, made the patient price-insensitive when demanding health care.

The proliferation of medical technology and the presence of full insurance, leading to moral hazard on the part of the patient, has historically shaped the service offerings in hospitals. Furthermore, the content and quality of services produced in a hospital are the result of a complex interaction among patients, physicians and hospitals with differing incentives and agency relationships. These relationships have changed over time necessitating a change in the complement of services offered in a typical hospital. Examination of the incentives and decisions each party faces is instructive in developing a model of strategic adaptation by hospitals to their changing environment. The following sections identify the objectives, incentives and behaviors of each participant in the health care system and how they have changed with the introduction of managed care.

### *Patients*

An individual patient who seeks health care attempts to maximize his or her expected utility from a health production function. The patient, however, may be unable to know which input combinations are necessary to increase his/her stock of health. Patients purchase insurance to indemnify themselves against the financial risk that results from the purchase of health care services. The presence of insurance creates an incentive for the patient to consume health care up to the point where his or her marginal benefit is equal to zero. In short, the patient's activities may be summarized as maximizing expected utility from consumption of health care subject to a lack of information on what is needed or how it will be accomplished.

The patient selects a physician to act as his or her agent in the purchase and provision of health care. If the physician were a perfect agent for the patient, he / she would demand and deliver the complement of services the fully informed patient would demand. The patient has little knowledge regarding the quality of the physician or the services the physician prescribes prior to using the services.

### *The Physician*

The physician seeks to maximize his or her utility function over effort expended, income, and perhaps patient or hospital benefit. Operating as an agent for the patient, he/she chooses the type and quantity of treatment. The physician may not be a perfect agent for the patient, however, as he/she is not compensated by the patient directly for services delivered but rather by the insurance company and as a result faces a more inelastic demand curve for his or her services than he/ she would if the patient paid the cost of care out of pocket.

Physicians provide care in hospitals. With respect to care delivered in hospitals, they determine not only the aggregate demand but also to a large extent the form of the hospital's production function; i.e., the physician chooses a hospital based on income derived from provision of care in the hospital setting and labor expended to deliver services in the institution. Physicians have more information than either the patient or the hospital with respect to what is needed to secure a patient's health. The physician's decisions are typically unconstrained in the case of indemnity insurance.

### *The Hospital*

The hospital is a multi-product organization that produces a wide array of services determined by physicians. Physicians are not typically or historically employees of the organization in the usual sense, and in the past they have not been bound contractually in any financial sense. The objective of the hospital is to produce returns for their stakeholders. In the case of the not-for-profit (NFP) hospital, the stakeholders may be the community or the physicians who deliver care in the hospital. In the for-profit hospital, the shareholders are the residual claimants. Hospitals do not control the production functions of their organizations, physicians do.[1] The hospital may make choices, however, regarding both the potential supply of inputs and the privileges of practicing physicians. In this way, through its choice of capacity, it effectively chooses the technology used to deliver services.

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[1] Over time, with the advent of the prospective payment system (PPS), hospitals have increasingly employed utilization review (UR) to constrain the physician's use of in-hospital resources. In the extreme this activity may take the form of economic credentialling, in which physicians' activity and admitting privileges are controlled as a function of the excess inputs they prescribe.

### *Health Maintenance Organizations (HMOs)*

Managed care organizations have grown over the last decade in response to the unchecked rise in health care costs. The objective of these organizations is to maximize profits or net consumer benefit in a competitive marketplace. HMOs accomplish this by one of two means, either by identifying practitioners who are of low cost and high quality, or by modifying the conduct of practitioners over time through enforcement of managed care practices and policies. These practices and policies take the form of incentives to providers or constraints on behavior enforced through monitoring. In practice, the growth of an HMO within a market usually proceeds in the following fashion. It enters the market and writes a contract with all (most) providers, imposing very little control or constraints on the system of providers. As it gains information on the practice of particular providers from claims it identifies those who are low cost and high quality as well as those who are receptive to change. This allows the HMO to create more powerful incentives and limit the size and number of contracts written.

The managed care organization writes contracts with providers which vary in terms of the degree of financial risk (capitation) transferred to the provider. If the managed care organization was able to manage care perfectly there would be little reason not to pay providers on a fee-for-service (FFS) basis. The problem is that it is very costly to monitor providers, and there is sufficient variation in the production of health for any one patient, that a "Managed Care Guidebook" cannot be written governing every possible disease state. The HMO must therefore rely on a combination of monitoring and incentives in an effort to get providers to deliver the "correct" amount of care at the right time.

Health maintenance organizations have assumed the insurance function from traditional indemnity insurers. They have an incentive to provide the least number of costly inputs to secure a given level of health. This incentive may be transmitted directly to the providers through capitated contracts. These contracts, which compensate the provider either per member per month or per disease episode, create an incentive for the provider to deliver services in the least costly fashion. The concern is that quality may be sacrificed in the process, particularly when it is difficult to measure the quality of the health produced and this information is not widely available in the market. In the presence of complete and noiseless information regarding the quality of a health plan, patients might simply vote with their feet and choose the highest quality provider for a given level of cost. It is conceivable that the growth of the HMO and capitation at large as a contracting form have been supported by advances in our ability to measure and quantify the quality of providers.

In summary, HMOs maximize profits subject to a lower bound on quality that is influenced by competition in the HMO marketplace. The patient who elects coverage by an HMO effectively transfers property rights to the HMO with regard to the treatment decisions to restore patient health. The HMO then transfers a subset of these property rights to the provider, retaining some measure of control, and constructs incentives and monitoring in such a way that care is delivered in a more "cost-effective" fashion. As can be seen from the preceding discussion, each party has differing incentives, sets of information and decision-rights. The introduction of managed care has changed each of these characteristics for each of the actors. These changes may result in a change in the behavior of each of the parties; an overview is provided in Table 1.1.

## Table 1.1 Effect of HMOs on Incentives

| | Indemnity State | HMO State | Change |
|---|---|---|---|
| Patients | **Objective**: Maximize value of health purchased.<br>**Information**: Knows disease state and potential demand for health care.<br>**Property Rights**: Choice of physician. Subject to this choice, decisions are transferred to physician.<br>**Incentive:** Consume all health care for which marginal benefit (MB) > 0. | **Objective**: Maximize value of health purchased.<br>**Information**: Knows disease state and potential demand for health care.<br>**Property Rights**: Choice of HMO. Subject to this choice, a physician is chosen and residual property rights are transferred from HMO to physician to deliver care.<br>**Incentive:** Consume all health care for which MB > 0 subject to supply-side constraints on what will be delivered. | **Objective**: No change.<br>**Information**: No change.<br>**Property Rights**: Constraints imposed on choice of provider.<br>**Incentive:** No Change. |
| Physicians | **Objective**: Maximize utility over income, effort expended, patient utility.<br>**Information**: Knows patient demand for services and necessary hospital production function for services.<br>**Property Rights**: Has complete control over how much and how health services are produced in office and hospital.<br>**Incentive:** Maximize inputs used to deliver health subject to MB to patient ≥ 0 (Do no harm). | **Objective**: Maximize utility over income, effort expended, patient utility.<br>**Information**: Knows patient demand for services and production function for services, in part influenced by HMO-supplied information.<br>**Property Rights**: Determines patient demand and production of health care subject to constraints imposed by managed care organizations.<br>**Incentive:** To the extent that the HMO capitates / monitors physician behavior, the physician is to maximize net benefit to the patient subject to constraints on provision of care introduced by theHMO and tradeoff in terms of physician income. The observability of quality may affect the lower bound on inputs delivered. | **Objective**: No change.<br>**Information**: The value of an individual physician's information may be predicated on additional information supplied by the HMO.<br>**Property Rights**: Has reduced autonomy in determining patient demand for care and how and where it will be delivered.<br>**Incentive:** Must trade off additional inputs delivered to patient with their effect on income subject to a reputation constraint. |
| Hospitals | **Objective**: Maximize profits or net consumer surplus (depending on FP / NFP organizational form).<br>**Information**: Knows resource use prescribed by physicians.<br>**Property Rights**: Able to choose the level of capital, which influences the level of inputs made available to physicians in the treatment of patients in the hospital.<br>**Incentive:** Since physicians determine patient flows and the production of hospital services, hospital chooses capital to attract physicians. | **Objective**: Maximize profits or net consumer surplus (depending on organizational form).<br>**Information**: Knows resource use prescribed by physicians.<br>**Property Rights**: Able to choose the level of capital, which influences thelevel of inputs made available to physicians in the treatment of patients in the hospital.<br>**Incentive:** Since HMOs determine patient flows and place constraints on the production of hospital services, hospital chooses capital level to attract HMOs. | **Objective**: No change.<br>**Information**: No change.<br>**Property Rights**: No change.<br>**Incentive:** Change in the equilibrium level of capital based on a change in the principal to which the hospital as an agent is responding. Choice of capital (or what is attractive to the party determining patient flows) reflects objectives of new principal – the HMO. |

In this thesis I develop a theory of strategic reorientation and formulation by firms. The model retains the notion of a maximizing hospital and potentially the more specific objective of profit maximization by placing the maximization undertaken by the hospital within the context of the constraints imposed upon it by interdependent parties. In short, the interdependence of the hospital's objective function with other organizations, firms or individuals places constraints on its ability to maximize globally. Changes in the constraints the organization faces over time result in changes in the orientation of the maximizing firm. The supposition of this work is that the constraints many firms face may be a function of the agency relationships to which they are captive. As these agency relationships change, so must the firm's response. Understanding the nature of the constraints imposed on the firm and how they change as a function of the agency relationships to which the firm is a party may lead to a greater understanding of firm behavior and thus firm strategy. Furthermore, the ability of the agent to tailor the form of the contract with the principal may be the heart of organizational strategy within a principal-agent (PA) framework.

This research is grounded in the complementary theoretical perspectives of agency theory and property rights. These well-received theories of managerial behavior have economic rationales as their basis and have been used to explain individual behavior within firms. This discussion extends the traditional focus on the individual to the firm as a whole.

### *Agency Theory*

Jensen and Meckling (1976) define an agency relationship as a contract under which "one or more persons (the principal(s)) engage another person (the agent) to perform some service on their behalf which involves delegating some decision making authority to the agent." This prescribes a theory for explaining individual behavior among principals (ill-informed individuals) and agents (informed individuals) who maximize their respective utility functions. The objective of the principal is to write a contract (composed of incentives and monitoring) with an agent who functions on his/her behalf to secure goods or services that the principal desires.

### *Property Rights*

Property rights literature is concerned with the allocation of residual claims to control decision-making authority or profits and how this influences the costs and size of the pie to be divided. Property rights are a social construct devised to prevent others from interfering with an individual in the use of goods or services, provided they are not precluded in the designation of the property rights. Further, as Demsetz notes, "property rights convey the right to benefit or harm oneself or others" (Demsetz, 1967, p.347). For the purposes of this discussion, an agent who has been given property rights over a particular decision may have the ability to harm or otherwise do a disservice to a principal. Internalization of the potential positive or negative externalities is central to a delineation of property rights: " A primary function of property rights is that of guiding incentives to achieve a greater internalization of externalities" (Demsetz, 1967 p.350). If the cost of transacting the rights between parties is greater than the benefits from internalization, then externalities are generated. For example, a physician who holds property rights over the determination of a hospital's use of resources might not bear the full cost of his/her decisions. Since hospitals are forbidden by law to negotiate with physicians based on cost, they are precluded from compelling the physician to internalize the costs.

Property rights further assign authority and control over residual claims that may be made against the proceeds from the provision of services. Fama (1983, p.331) notes:

> " .... when residual claims are not freely alienable or separable from other roles in the organization, it is rational for risk bearers to attribute lower current value to uncertain cash flows than is implied by capital market prices for future resources. As a consequence, ignoring agency problems in the decision process, organizations with common stock residual claims, investing according to the market value rule which is optimal for their residual claimants, will be able to deliver products at lower prices than organizations with restricted residual claims."

This accurately describes the physician's historical relationship with a hospital as both the residual claimant and the producer of services. The hospital as a physician's co-operative is an organization with restricted residual claims (Pauly, 1980). The present-day hospital, particularly given the growth of the for-profit organizational form, has increasingly been able to separate the residual claims from the physician and transfer them to the managed care organization and, potentially, the patient. The very success of hospitals may be predicated upon this activity.

Arrow suggests that the presence of risk-aversion on the part of the agent is necessary for a non-trivial solution to the PA problem. If the agent were risk-neutral, he might efficiently bear all the risk, the principal could retain a fixed amount, and the agent would receive the residual. The example of a landlord renting land to a farmer is given as evidence of such a case. Now, however, consider the case of a patient (the ill-informed principal) and a physician (as the agent for the patient). The relationship between these two parties differs from the landlord-farmer example in important ways. The risk-averse physician makes decisions that affect his or her own wealth and the corresponding health of the patient. One important difference is that the patient is hiring the doctor to produce a good that has no residual value to the physician unless patient utility is explicitly valued by the physician above and beyond the effect it has on his or her income. It is also the case that the good produced is an output in kind; that is, it cannot be transferred into a form that can easily be expropriated by the physician.

There exist numerous applications of agency theory to the relationship between physicians and patients (Blomqvist, 1991; Ellis & McGuire, 1986; Labelle, Stoddart, & Rice, 1994; Mooney & Ryan, 1993). There are, however, no models employing an agency-theoretic perspective examining the relationship between firms (in this case hospitals) and other interdependent parties (in this case HMOs). This thesis will develop such a model and demonstrate how it may be used to guide the formulation of hospital strategy.

More importantly, hospitals are limited in their ability to reconfigure their organizations to meet the changing managed care demands, due to the presence of imperfect agency on the part of the physician. The physician's preference for delivery of inputs and the hospital's ability to affect its production function only indirectly results in the hospital indirectly limiting the supply of inputs through its choice of capital and monitoring. Moreover, the hospital's choice of capital or technology sends a signal to HMOs in the market regarding the level of inputs and care that they might reasonably expect from the hospital. The hospital therefore has at its disposal two methods for reducing the intensity of service delivered to managed care patients, direct reduction or rationing of available inputs and monitoring. The question, however, remains as to whether these two mechanisms are complements or substitutes and which mechanism increases hospital performance. My research sheds light on this question of fundamental interest to hospital managers.

To the broader theoretical audience this thesis is an empirical test of agency theory and organizations' ability to control the agency relationship through monitoring and other constraints on the agent's choice set. While much of the principal-agent literature is concerned with redressing the agency conflict, few have empirically estimated alternative methods for changing an agent's behavior. In addition to testing the effect of monitoring (often recognized as a means for ensuring an agent's compliance with a principal's objectives), this thesis also tests an alternative, capacity reduction. The reduction of a hospital's capacity is tantamount to rescinding the property rights granted to the agent. This examination will indicate when to monitor and when to hold back property rights to achieve the outcome desired by the principal.

## Chapter 2: Literature Review

Principal agent (PA) theory attained popularity in the financial economics literature (Jensen and Meckling, 1976; Ross, 1973) and was historically concerned with the relationships between stockholders (principals) and firm managers (agents). More recently, however, the PA approach has been employed profitably and has diffused widely into the disciplines of organizational theory (Fama, 1980), strategy (Eisenhardt, 1989) and organizational size and structure (Levinthal, 1988; Williamson, 1985; Yarbrough & Yarbrough, 1987). Hart and Moore use an agency-theoretic perspective to examine the differences between ownership of assets and contracting for inputs and conclude that contracting has benefits due to the ability to "fire" subsets of the employees, which is not possible if employees are owners (Hart & Moore, 1990).

Hill and Jones (1992) combine PA with stakeholder theory (Freeman 1984). Stakeholder theory suggests that the presence of an exchange relationship between two parties confers a legitimate claim on the firm. The size of each stakeholder's stake in the firm is a function of investments in specific assets (Williamson, 1984). Stakeholders may have direct control over the firm, as in the case of a firm's managers, or indirect control, as in the case of a supplier or customer. Hill and Jones challenge a fundamental assumption of agency theory, efficient markets, and through the use of the Austrian-school perspective, allow for the existence of power differentials arising from short-run disequilibrium. Strategies pursued by managers are posited as attempts to exploit these power differentials, and as a result amendments to the existing contracts between principals and agents will arise.

Mukherji and Nagarajan (1995) examine incentive contracts and investment decisions in a two-stage model of investment by the agent. In the first stage the agent undertakes an unobservable action which sends a signal to the principal at the end of stage 1. The principal, upon viewing the signal, decides upon the level of investment in stage 2. The authors show that, given the agent's preferences, over-investment (on the part of the principal) will occur because of a first-stage incentive problem. In addition, they show that, if the contractibility assumption is relaxed, and the investment decision is delegated to the agent, the principal's optimal strategy is to under-invest. Finally, they note that the imposition of realistic constraints on contracting can have a significant impact on the predictions of an economic model.

Of particular relevance to the PA problem in health care is the form of PA contracts in the presence of moral hazard and adverse selection as discussed by, e.g., Christiansen (1981), Demougin (1989), Laffont and Tirole (1986), McAfee and McMillan (1987), and Sappington (1984). In general, these models suggest that the principal should offer the agent a menu of contracts, and the agent will choose the contract that maximizes his or her utility given his or her type. In this way it is possible to select agents of a particular type without observing the type. Demougin's result differs in that it employs an optimal sharing rule based on production outcome and does not rely on agents reporting their types.

While all of these models are sensitive to their assumptions regarding the information structure, objectives, incentives and allocation of property rights, in them the uninformed principal contracts with an informed agent who performs some task from which the principal benefits. The models incorporate informational asymmetries – the agent has more information than the principal; incomplete observability – the principal may not observe the effort invested by the agent; risk-aversion – the agent is typically risk averse, precluding assignment of residual claimancy; moral hazard (Grossman & Hart, 1981); and an inability to write complete contracts – the task to be performed by the agent is so complex or varied that either a complete contract can not be written or the cost of writing it would preclude a transaction..

Various perturbations on the objectives, information sets and asymmetries lead to a myriad of possible conflicts, all of which may be redressed through the governance contract and control mechanism between the principal and the agent. The governance contract comprises the optimal level of monitoring and incentives to minimize the cost of production for a desired level of output. While each of these facets of the agency problem introduces additional contracting difficulties, a solution to one dimension does not necessarily solve the problem. For example, elimination of informational asymmetries between principals and agents may not eliminate agency problems (White 1992).

Agency models are well suited to address situations in which there problems with the verifiability of information or information is held privately and it is not in the agent or principal's best interests to divulge it. Fundamental to the agency model is that some actions taken by the agent are not observable to other agents or principals. In response to the presence of this information asymmetry, MacDonald (1984) considers three solution classes: 1) acquisition of information, or monitoring; 2) rearranging the pattern of allocation so that informational asymmetries have less of an impact; and 3) designing an exchange between the principal and agent based on observables (MacDonald, 1984). He goes on to suggest two logical classes of extensions to the PA model, 1) the consideration of external markets and 2) richer agency settings. The model put forth in Chapter 3 capitalizes on this prior literature and attempts to extend the PA literature in this way. The predictions of all these models are sensitive to each of the constructs which constitute the agency problem; general results are few.

### *Agency in Health Care*

The agency-theory perspective is not new to the analysis and consideration of actors in the health care system. Many of the relationships that exist between parties in the health care environment, patients, doctors, hospitals, and insurers, exhibit the problem of information asymmetry, incomplete contracting, and differing incentives resulting from differing utility functions. This is not meant to suggest, however, that the agency perspective has been employed profitably in normative analyses of provider behavior: "Agency in health care has to date been used primarily as no more than a description of behavior. That is, there is comparatively little analytical work on [agency theory] in health care" (Mooney & Ryan, 1993 p.125). Mooney and Ryan further suggest that the interdependence of the actor's utility functions limits the transferability of mainstream micro-economic agency theory to health care, and that only through a more robust characterization of the elements of the utility function might we make advances in remuneration systems that might influence providers' behavior.

The perspective taken in this work is fundamentally different. In particular, while the interdependence of the patient and doctor and of the doctor and hospital is well established, I believe that this interdependence is diminishing over time, making the application of agency theory more relevant and more straightforward, with greater promise for providing insight into how providers may behave under alternative contracting structures. This paper recognizes the change that has taken place in the organization of health care delivery, the advent and growth of the managed care organization, and examines how this has changed the agency relationships that exist between doctors and hospitals. It is my premise that the growth of managed care has fundamentally changed these relationships and changed the very nature of the equilibrium contracts that need to be written between these actors, the definition of the product, and the production of services. Agency theory and these new relationships may be instructive in predicting and explaining the behavior of health care providers in general, hospitals in particular.

The presence of information asymmetries, differing objectives and the inability to write complete contracts among patients and providers makes the agency theory perspective relevant when thinking about the inter-relationships among health care providers. In particular, two agency relationships may impinge on the hospital's provision of service: the relationship between the doctor and the patient as well as the relationship between the hospital and the physician ( see e.g., Pauly & Redisch 1973, Pauly 1980). The physician operates as an agent for the patient, who is uninformed with respect to the need for health care services and how they should be produced. The patient has historically transferred property rights over the treatment decisions to the physician, who acting as an agent for the patient determines the demand and production function for health services. As a result, if the physician is acting as a perfect agent for the patient, the production function, level of services delivered and resources committed in the hospital reflect will reflect that agency relationship. Given the uniqueness and importance of this dual agency role, it is important to examine how hospitals may respond and configure their organizations in such a way that they may minimize the agency costs.

### *Literature on Hospital Behavior*

There have been numerous empirical studies to date examining the effect of hospital competition on hospital cost and quality outcomes. In summary, prior to the implementation of prospective payment in 1983, hospitals were thought to compete for physicians or patients through the provision of amenities and technology. The fundamental change in the reimbursement mechanism changed the dimensions upon which hospitals compete. A particularly noteworthy omission from this literature, however, is what hospitals specifically did to achieve the desired outcomes which were rewarded in the new market context. This question is of practical importance.

The results from studies of hospital competition have been far from consistent in their results: Competition has only modest cost-increasing effects (Fournier & Mitchell, 1992). Price and quality competition are greater in less concentrated markets (Noether, 1988). Costs for public and for-profit hospitals are found to be unaffected by market structure (Santerre & Bennett, 1992). Competition reduces prices (Melnick et al., 1992). Post PPS competition has lowered hospital costs significantly (Zwanziger & Melnick, 1988).

The effect of managed care on competition and hospital activity has been studied as well with similarly mixed results. There is no change in price competition (pre- and post- PPS), but an increase in service competition (Manheim, Bazzoli & Sohn, 1994). Staff-model HMOs shop for hospital services based on price (Feldman, et al., 1990). Greater hospital competition leads to lower prices; furthermore, as the importance of a hospital to the PPO in an area increases, the price rises substantially (Melnick, et al., 1992). Staten, Dunkelberg, & Umbeck (1987) test the argument that monopsony power on the part of insurers may lead to greater discounts, but find no support for this in their study of 110 Indiana hospitals.

In recent years there have been a number of empirical studies which have examined dimensions of hospital behavior, such as: inter-organizational relationships, including alliances (Zuckerman & D'Aunno, 1990) and mergers (Lynk, 1995). Alexander (1990) studied the diversification behavior of 100 multihospital systems between 1983 and 1985 to evaluate the way systems respond to: resource complaints, uncertainty, and competitive pressures on inpatient care. Findings suggested that, during this period, multihospital systems pursued or continued to pursue a diversification strategy. Measures of diversification were based on a listing of the 19 services or products meeting several prespecified criteria, and only 5 experienced significant rates of adoption by systems during the timespan studied. Service-specific diversification among multihospital systems did vary by type of system (Alexander, 1990).

Zajac & Shortell studied two sources of theoretical tension relating to changing strategies: the notion of equally viable generic strategies versus particularly appropriate strategy-environment combinations, and the relative influence of process versus content issues. Their results suggested that: organizations generally do not change their strategies in response to major environmental shifts; the impact of a specific major environmental shift can influence changes in strategy in a nonrandom way, with organizations in the aggregate moving away from one generic strategy toward other generic strategies; and organizations' prior strategy can be a very strong discriminator of those that changed their strategies (Zajac & Shortell, 1989).

The one recent empirical study of hospital reconfiguration found that competition among hospitals tended to increase differentiation, whereas higher financial PPS pressure is associated with increased specialization. Hospitals adopt some high-visibility services offered by their competitors while filling market niches selectively overall. It also appears that the savings expected for specialization may prevail only for narrowly defined services (Zwanziger, Melnick, & Simonson, 1996). These results however , do not consider the presence of managed care in the hospital's marketplace however.

Zwanziger's 1996 results aside[2], the previous research in this area raises more questions than it answers. While many have examined the role of competition on hospital costs and quality with varied results depending on the time frame studied, little research has been conducted to study how hospitals have changed their organizations to arrive at the observed changes in cost, quantity and quality. Furthermore, Zajac's results suggest that hospitals do not respond to their environment in predictable ways. Most of the research observes market-level phenomena, (the effect of decreases in price paid on the output of the hospital) rather than developing a model that might give greater insight into why managers make particular decisions and how those decisions are influenced by market and firm characteristics. The model in this thesis could be extended in this way.

Another noteworthy omission in the literature is that, given the importance of the PA problem in health care (Custer et al., 1990; Ellis & McGuire 1986), there has been scant evidence on how hospitals may control this problem, how this problem is changing over time or how the agency costs may affect sub-optimal behavior by the hospital. This thesis addresses these topics both theoretically and empirically.

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[2] Zwanziger examined differentiation and specialization which are a composite measure of many changes made in the hospital rather than looking at specific actions and how they relate to changes in the market in which the hospital resides.

# Chapter 3: Theoretical Model

The preceding literature review has suggested what we know and what we do not know about strategic adjustment within the context of a changing industry. This section develops the principal-agent relationship between the physician and the hospital and shows how this will affect the strategic behavior of the hospital. In addition, it develops a model for the hospital's response to managed care through either capacity reduction or increases in monitoring the delivery of hospital inputs. As a result, monitoring and capacity reduction will be the two strategic choices empirically examined in this research.

These are, however, just two of many different strategic decisions a hospital may make in response to changes in its environment; the choices of scale and capital, while important, are a subset of the potential choices made by hospitals. Hospitals are increasingly forming inter-organizational relationships with other hospitals and health care providers. They are merging in an effort to rationalize services across facilities, forming joint ventures and forging strategic alliances[3]. Hospitals are also forming physician hospital organizations (PHOs) for the purpose of contracting with managed care organizations[4]. Hospitals are purchasing physician practices as well to secure a stable source of referrals and address the differing incentives individual physicians posess[5]. Finally, hospitals are reviewing the scope of services delivered as well as where these services are delivered. These additional strategic decisions are important although they fall outside the scope of the analysis in this thesis. The level of monitoring contingent on accepting managed care contracts, while important in its own right, may also be an indicator of the potential benefit from coordinating production with physicians through integration. The level of capacity reduction may be related to other strategic decisions not measured directly. Large reductions in capacity in response to managed care may lend support for concentrating admissions in a smaller set of hospitals; this would be equivalent to mergers and closures. Hence, the focus of the theoretical model as well as the empirical analysis will be on the role of monitoring and capacity reduction.

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[3] Data on non-equity-based hospital relationships are not readily available. This information, to the extent that it confers a competitive advantage, is often not publically disclosed, or is there a central repository for alliances among hospitals. The benefits that may result from these integrative relationships do not address the agency problem. Finally, while being part of an alliance among hospitals may reduce the contracting costs with an HMO, it is unclear how the control structure of the alliance will affect the potential reduction in hospital capacity. As a result, inter-organizational relationships are not addressed. It should be noted, however, that the theoretical model of this chapter does suggest that there may be an increased incentive for hospitals to merge if merging facilitates capacity reduction.

### *Narrative Argument for Reduction in Level of Services*

While the ensuing two sections argue for the importance of the agency problem between the hospital and the physician as a determinant of the strategic response to managed care, it is instructive to first examine hospital response in the absence of the agency problem. The point to be made is that hospitals are likely to have an incentive to reduce capacity in response to managed care regardless of the magnitude of the agency problem between physicians and hospitals. Thus, a simple narrative argument is sufficient to motivate the theoretical discussion that follows. The agency problem and the way in which HMOs influence hospital behavior are key problems facing managers of hospitals. Addressing these two issues provides greater insight into how much reduction will occur and has implications for how hospitals should effectively limit the delivery of inputs.

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[4] A PHO may come in many forms based on the size of the panel as well as the decision rights, incentives and investment of the physicians. This population of PHOs is constantly changing or evolving. As a result, this information is not readily available today. At the time of the study, particularly in the earlier years, it is unlikely PHOs were prevalent.

[5] Many non-profit hospitals have purchased physician practices and for-profit hospitals have entered in joint ventures with physicians. The number of purchases is not reported.

## No Agency Problem Between Hospital and Physician

Individual consumers or patients choose to enroll in a managed care plan based on their expected health care needs, the prices they face, their income, and their expectations with respect to the services that will be delivered under the plan[6]. Consumers of the plan recognize that in return for the lower price they are likely to receive a more restrictive health care product. While consumers may not explicitly desire a lower level of service, they are trading off any restriction or reduction in the number of inputs delivered with the lower cost of the plan. This tradeoff reveals a preference for either a lower price or lower quantity. Furthermore, individuals who choose the plan may have a lower expected demand for health care in general, which would support, in aggregate, a lower level of services to be demanded from providers by the HMO.

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[6] This assumes that individuals select and purchase a health plan through their employer. It also assumes that employers offer a menu of choices. While this is often the case in large organizations, many smaller employers may limit the choice of health plan. This constrains the individual employee's choice, so selection of a managed care option may not truthfully reveal his or her preference. To the extent that employees' when choosing a health plan are not afforded the opportunity to choose, the actions of the HMO may not be interpreted as an aggregation of the preferences of the consumers of the plan. It is also important to note that the HMO may not be acting as a perfect agent for the patient but rather may be maximizing its own objective function. If consumers are not able to vote with their feet, as in the case of limited choice, the health plan may be able to constrain the delivery of inputs to patients beyond what they would choose if they knew the constraints and cost of the plan. In this case, the HMO could extract a surplus from the consumers and in the absence of a competitive market secure rents. The lower level of inputs chosen by the HMO may not necessarily represent the "optimal" choice of a fully informed consumer. That said, it is true that HMOs will demand a lower level of inputs from the hospital, but this model does not address the agency and market imperfections which may lead to this lower level.

As a result, managed care organizations are assumed to desire fewer hospital inputs – a lower level of R in the ensuing model. Hospitals have traditionally chosen levels of capacity, technology and capital consistent with the demand determined by traditional indemnity insurers. Due to the nature of the contracts these insurers have written with providers, there is demand for hospital inputs and services up to the point where the marginal benefit to the patient equals zero[7]. Managed care plans, on the other hand as an aggregation of the revealed preferences of consumers choosing the managed care product, exhibit less demand because of the selection effects of patients in managed care plans, the form of the contracts HMOs write with providers, and the explicit hard constraints imposed on providers. In short, a portion of the hospital's demand curve now receives a lower level of intensity.

Hospitals have chosen their level of technology and capacity based on the efficient production of services for a population that desires a high level of services – the hospital is operating at the minimum of a short-run average cost curve (SRAC) determined by FFS insurers. To achieve the lower level of inputs desired by the HMO, the hospital must constrain or otherwise limit the supply of hospital inputs. This is achieved by retiring hospital capacity. By reducing the fixed cost associated with the production of health services, the hospital is able to move to a "new" SRAC that reflects a lower demand by the HMO segment of its demand schedule. If we assume that a hospital cannot differentiate its production function based on the type of insurer, then the resulting SRAC is likely to be a mix of the SRAC for the managed care population and the old SRAC for the traditional indemnity insurer.

The amount of the reduction and how this reduction is made are a function of the agency problem and the role of the HMO. The agency problem that exists between the physician and the hospital may lead to a smaller reduction than would be the case in the absence of the agency problem. In addition, the agency costs may affect the magnitude of the reduction through the impact of these costs on the overall hospital cost function. The managed care organization further has differing incentives to limit the delivery of inputs to their managed care population. If the FFS insurer price is above marginal cost, the hospital cannot fully differentiate its production based on insurer status, and if the hospital is concerned with breaking even overall, a cross-subsidy may exist between the FFS population and the HMO population. This may dampen the incentive of the managed care organization to write high-powered contracts to limit the delivery of inputs to the managed care population. The form of the contract the HMO writes with the hospital is affected by the FFS contract and it in turn affects the HMO demand for hospital services. This demand for hospital inputs influences the capacity reduction or monitoring of inputs to HMO patients.

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[7] This assumes patients are fully insured and face no meaningful co-pay or deductible when seeking care. The assumption regarding the nature of FFS insurance will be used throughout this chapter.

## The Presence of Agency Problems:

Constraining the hospital supply of inputs is a non-trivial venture. Hospitals do not directly employ physicians[8]. Managed care organizations and FFS insurers write contracts separately with hospitals and physicians. Physicians, however, subject to their own fee schedules, determine hospital demand as well as the hospital's production function. Physicians do not directly share in returns to the hospital from the efficient provision of care in the hospital. To the physician, prescription of hospital inputs is largely costless. As a result, a hospital which now has a portion of their patients requiring a lower level of inputs is faced with the challenge of constraining the physician's supply of these inputs[9].

Figure 3.1 depicts ideal or optimal hospital short-run average cost curves under different payer compositions (and corresponding demanded levels of inputs) for a hospital with a given capital endowment K. In the presence of only FFS insurers, the hospital is operating at the minimum ($R_{FFS}$) of curve 1. The hospital has in place a complement of capital and monitoring to deliver care efficiently based on the FFS insures demand. Assume that at some point a managed care plan writes a contract with the hospital desiring a lower level of inputs for their clientele – say $R_{HMO}$. In the short run, the provision of a lower level of service to the HMO patients would be more costly, in part because in aggregate the hospital has slid back up its SRAC curve, but also in part due to the additional marginal costs of monitoring the physicians and constraining supply[10]. This is shown in figure 3.1 as (A). Given time to adjust the hospital may reduce its level of capacity or fixed costs so that it enters a new SRAC taking into account the HMO% it faces. This is depicted as curve 2 in Figure 3.1. The hospital will set its complement of capacity and technology so that it is at the minimum of the SRAC at $R_{HMO}$. This does not correspond to a simple reduction in hospital demand, as would be the case if FFS demand was reduced. Because of the prospective method of payment, the hospital has an incentive to limit the delivery of hospital inputs, and while the retirement of some capacity achieves this end, it is still likely that the hospital will have to engage in monitoring to ensure that physicians – subject to their own fee schedules – are not over-employing hospital inputs. This has the effect of again increasing the marginal cost to the hospital as the desired level of inputs delivered is reduced.

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[8] The theoretical discussion has focused on hospital efforts to control physician agency by retiring capital (thereby limiting physician access to hospital inputs) or monitoring. While these methods may be effective in limiting the agency problem there are other alternatives. Increasingly not-for-profit and for-profit hospitals alike have attempted to more closely align physician incentives through various integrative measures. Hospitals that attempt to integrate with physicians have multiple objectives including securing a stable patient flow and aligning incentives. Not-for-profit hospitals have purchased physician practices in an effort to secure physician loyalty. For-profit hospitals such as Columbia/HCA have encouraged physicians to become minority shareholders. This may also create an incentive for physicians to admit their patients to their hospitals. It is not clear however, that these mechanisms have been effective at better aligning the physician's objectives with those of the hospital. Hence, this extension is not developed in this thesis. While integrative forms of physician-hospital relationships are increasing in popularity, data on these relationships are not available. Furthermore these relationships do not necessarily eliminate the agency problems, so these relationships are omitted from my analyses as well.

[9] This may also explaining the growth of integrated delivery systems (IDS) in response to managed care penetration among other forms of hospital-physician collaborative relationships. The desired effect of such integration strategies is to achieve a greater alignment between the incentives of the physicians and the hospital. Effective integration of the physician's utility function with the hospital's objectives may limit or bound the degree of imperfect agency.

This figure is an attempt to motivate in general terms the behavior which the ensuing models will develop more specifically. In short, the hospital must reduce the delivered level of inputs to HMO patients to be successful. This may be accomplished by either 1) reducing the available inputs which physicians may prescribe or 2) monitoring physicians and staff in general to ensure that hospital inputs are rationed. In practical terms, the hospital may either reduce the number of beds, thereby limiting the physician's ability to keep the patient in the hospital an additional day, or they may increase the staff which oversees the use of hospital beds, thereby increasing pressure on the physician to discharge the patient as soon as possible.

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[10] It is assumed for the sake of simplicity that hospitals which are reimbursed on a fully FFS basis are paid in such a fashion that reimbursement covers the costs of care delivered, regardless of the physicians choice of hospital inputs.

The work of Custer et al. (1990) is most similar in spirit and argumentation to the discussion in this chapter. In their paper, Custer and his colleagues address the importance of the relationship between the hospital medical staff and the hospital in determining the effect of prospective payment on the level of hospital inputs delivered. Their model resulted in four insights. First, an efficient input mix is only attainable when the per unit reimbursements for hospitals and physicians are identical. Second, the total quantity of care delivered after the introduction of PPS will fall. Parenthetically the authors attribute this to the removal of the hospital's incentive to 'over-supply' inputs. This explanation differs from the model put forth in this thesis, which asserts that hospitals only indirectly affect the level of inputs delivered through monitoring and rationing of hospital inputs. The third insight they offer is that a budget-neutral change in the reimbursement of hospitals will result in a reduction in physician income. Finally, the introduction of PPS will increase the incentives for physicians and hospitals to collaborate or otherwise integrate in the delivery of health care. To the extent that this is a lower cost means of delivering a lower level of service

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Hence such hospitals do not need to engage in monitoring. This is obviously a polar example, but it makes the than either monitoring or rationing the availability of inputs, the argument in this thesis is consistent with their observation. The model here fundamentally extends the work of Custer et al. by building in the mechanism by which the hospital supply of inputs is determined and how the degree of imperfect agency affects the hospital's action to control the supply of inputs.

To make this argument more clear, two models follow:

- Characterization of physician agency
- Hospital choice of capacity

The first, a characterization of physician agency, demonstrates the divergence between the physician's objectives and the hospital's objective when both are subject to differing fee schedules. This motivates the agency problem the hospital will have to control when HMOs write capitated contracts with hospitals and physician incentives are not aligned with those of the hospital. The second model characterizes the hospital's choice of capacity or capital, K, in response to increasing HMO penetration. This model solves the capacity decision problem conditional on the nature of the agency relationship. It shows that the hospital will reduce the level of capacity, thereby tracing out a new SRAC. In addition, it suggests the importance of the imperfect agency relationship between the physician and the hospital and how this will affect the quantity of services delivered. Drawing on the argumentation from these two models, the chapter concludes with a set of testable hypotheses.

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point more clear.

### *3.2 Characterization of Physician Agency*

The model has two actors, the physician and the hospital, who solve independent profit-maximization problems. While profit maximization on the part of both agents is a simplification, it has been used convincingly as a valid approximation of individual behavior elsewhere (Pauly & Redisch, 1973). I will discuss later the implications for relaxing the profit maximization criteria on the part of both the physician and the insurer. Additionally, I consider only the interaction between one doctor and one hospital in the model, although I recognize that many physicians admit to more than one hospital. Moreover, I do not consider the interaction among multiple physicians within a particular hospital, although their interaction may mitigate against free-rider problems. Furthermore, the presence of many physicians in a hospital may increase the costs of monitoring to the extent that monitoring does not exhibit economies of scale.

#### The Hospital Problem

Hospitals are assumed to maximize profits equal to revenue, R(Q), less costs C(Q). I assume that third-party payers reimburse hospitals for service by a capitated DRG payment. Under such a payment structure, hospitals receive a fixed payment per hospitalized patient within a DRG. The economic implication for prospective payment is that there is no direct relationship between revenue and costs. The hospital's revenue is given by $R(Q) = \overline{P}Q$, where $\overline{P}$ is the capitated payment per patient and Q is the total number of patients hospitalized. For simplicity and without loss of generality, I choose to model only one DRG classification. The model could be extended to consider the full range of DRGs[11]. Since the focus of this model is on the equilibrium choice of inputs, the quantity of patients hospitalized, Q, is assumed and suppressed throughout.

The hospital is assumed to incur production costs for the care of patients within each DRG. These production costs are associated with inputs controlled in part by the hospital and in part by the physician. Examples of inputs under the control of the hospital include bed capacity, hospital staffing, and capital investment in technology; these associated costs are incurred by the hospital and are assumed to be fixed in the short run. Examples of hospital inputs under the control of the physician include the volume and types of tests ordered and the units of nursing labor required for any prescribed treatment plan; the costs associated with these physician-controlled inputs, however, still accrue to the hospital. The costs of the hospital inputs under the control of the physician are given by $C^{MD}(X)$[12] and are assumed to be a function of the number of inputs per admission, X.

Given that no explicit contractual relationship exists between the hospital and the doctor, and that each actor is assumed to be acting in his or her own self-interest, it is possible that the physician may choose levels of X independent of the level the hospital would choose if it were maximizing its own objective function[13]. The hospital may affect the physician's choice of X by either rationing the availability of an input or monitoring the delivery of the input to ensure that the marginal benefit, from the hospital's perspective, of an additional unit of the input is equal to the marginal cost to the hospital. Examples of hospital rationing activities are rationing hospital beds, creating queues for access to the operating rooms and, in the most extreme case, revoking admitting privileges. Alternatively, the hospital may choose to monitor the physician by engaging in utilization review activity designed to constrain the physician's use of hospital inputs. Each of these activities may control the agency problem by increasing the cost to the physician for stating his or her desired level of inputs. Only when the marginal benefit from the physician's perspective is so great as to exceed these costs will the physician persevere and deliver the hospital's input.

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[11] Furthermore, the hospital does not control Q, which is exogenously determined in the short run, and the existing distribution of hospital admitting privileges.

[12] Throughout this chapter and in all models which follow, superscripts will identify actors and subscripts will identify partial derivatives with respect to function arguments.

While these activities control the costs accruing to the hospital, they are not undertaken costlessly. The hospital incurs a cost for these activities, I, which is the investment made by the hospital to constrain costs[14]. Though the hospital may not choose the number of inputs directly, through the its choice of the investment in utilization review or monitoring the hospital may influence the level of X delivered. There is an attendant benefit to the hospital for such activity in terms of a reduction in the number of inputs delivered to the patient. This benefit is the savings derived from limiting the physician's use of hospital inputs. The hospital's choice of activity level is assumed to be subject to some lower bound on quality, which is assumed to be fixed throughout the model[15]. There is a diminishing marginal effect of investment in monitoring or utilization review on the number of inputs delivered, $X_I < 0, X_{II} > 0$.

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[13] Alternatively, the level of inputs chosen by the physician may be different from the level chosen by a physician whose incentives were aligned with the hospital's. This case is developed by Pauly & Redisch (1973) and by Manning (1973), where the hospital is modeled as a physicians' co-operative. Manning shows that the cooperative form will set the marginal revenue* the physician's marginal product equal to the average physician member income. Manning notes, however, that this is different from the profit maximizing twin because the co-op uses physicians to the point where the last physician contributes to the collective income just his share of the total income. The twin, on the other hand, uses physicians up to the point where the last physician adds the opportunity cost of his time.

[14] The level of I, investment in monitoring, is a function of the level of X, which has been suppressed for simplicity.

The hospital cost function (as determined by the physician) with respect to monitoring is assumed to satisfy standard cost function conditions and is convex with $C^{MD}{}_I < 0$ and $C^{MD}{}_{II} > 0$.

From the above, the hospital chooses a level of investment, (I), in monitoring / utilization review to solve the following profit maximization problem:

$$\pi_{hosp} = \overline{P} - \left(A + C^{MD}\left[X(I)\right]\right) - I \qquad (1)$$

$$\text{F.O.C wrt I} \quad 1 = -C_X^{MD} X_I \qquad (2)$$

The FOC states that the marginal cost of monitoring is constant ( equal to 1), and this is set equal to the marginal cost per additional unit of input X multiplied by the effect of an additional unit of monitoring on the reduction in X. Assuming that $C_X$ exhibits constant marginal cost, c,

$$X_I = -\frac{1}{c} \qquad (3)$$

In equilibrium, the marginal effect of an increase in I on the change in the number of inputs delivered is equal to the inverse of the marginal cost of an additional unit of hospital input.

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[15] If the hospital rations inputs to such a degree that the quality of the services is reduced, either patients or

## The Physician Problem

Physicians are assumed to maximize profits; they are reimbursed on a set fee schedule determined by a third-party payer. The physician's revenue is PX, where P is the fee paid to the physician for each input delivered and X is the number of inputs required to deliver each service and is chosen by the physician. The physician incurs a cost for providing service equal to C(X, I)[16]. This cost reflects the opportunity cost of his own labor and any additional physician-specific support services as well as the disutility from monitoring. The physician does not incur any explicit cost for his use of complementary hospital inputs. However, the physician does incur an additional cost imposed on him by the hospital's monitoring / utilization review activities, I. Physician costs are concave in I, $C_I > 0$, $C_{II} < 0$, $C_{XI} > 0$, $C_{XX} > 0$.

The physician maximizes profits with respect to his choice of the number of hospital inputs, X. The physician chooses a level of X recognizing the cost of monitoring imposed on him by the hospital ($C_I$):

$$\pi_{MD} = PX - C^{MD}(X, I(X)) \qquad (4)$$

$$\text{F.O.C wrt X} \quad P - C_X - C_I I_X = 0 \qquad (5)$$

The first-order conditions show that the physician sets his marginal revenue equal to the marginal production cost of caring for the patient ($C_X$) plus the marginal cost of the monitoring imposed by the hospital

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physicians may choose to seek another hospital.

[16] Monitoring imposes both psychic and time costs on the physician. It is costly for the physician to continually justify the use of additional hospital inputs.

The interaction between the physician decision and the hospital decision can be incorporated by solving their corresponding first order conditions simultaneously so that there is a solution ($X^*$, $I^*$) in which each actor's choice of X and I respectively is a best response to the other party.

Manning (1973) showed that as a result of the separation between physician and hospital incentives the motivation to minimize costs is replaced with incentives for too costly provision of health services. In both the Co-op and Cournot models this separation leads to non-cost-minimizing behavior in the choice of input combinations to produce health services. The presence of FFS insurance further exaggerates these inefficiencies. This model adds additional evidence of the cost inefficiency resulting from separation attributable to monitoring by the hospital. This was not considered in Manning's work, since at the time managed care was largely a proposal rather than a market force.

### The Hospital-Physician Problem Together: Joint Production

In the above formulation of the problem, the actors separately maximize profits because of the traditional at-arms-length relationship between the hospital and the doctor although they are acting jointly and with common inputs to produce health. When considered jointly, however, an inefficiency in health care production clearly results from the fact that the physician does not take into account the effect of his actions on the hospital and the hospital does not consider the monitoring costs imposed on the physician. Specifically, the physician does not consider the marginal costs to the hospital for employing an additional unit of the hospital's input (X). Similarly, the hospital does not consider the costs imposed on the physician by the hospital's selection of the level of utilization review (I). Moreover, if they acted jointly, the physician would no longer prescribe hospital inputs as though they were free, thereby diminishing the need for utilization review. The incentives of each actor create a need for monitoring which is not present if their objectives are perfectly aligned. The savings from integration would be the avoided cost of monitoring. The difference between the physician's choice of X in his or her own problem and the level of X chosen in a coordinated maximization problem may be denoted $\theta$, the degree of imperfect agency, and will be expanded upon in the model in section 3.3.

The combined entity may therefore be able to achieve additional efficiencies in production if the hospital and the physician are able to structure an incentive-compatible compensation mechanism such that the physician makes decisions regarding the use of hospital inputs and his or her own labor based on prices that reflect costs across and within treatment types.

The implications from the preceding discussion may be summarized in the following points:

1. Physicians, even if they are profit maximizing, may not choose hospital inputs to maximize hospital objectives.
2. The degree of monitoring is positively related to the magnitude of the agency problem.
3. The magnitude of the agency problem is a positive function of the disparity in relative incentives from the independent fee schedules.
4. Managed care or capitated payment in general will exacerbate the agency problem requiring more monitoring.

### *3.3 Hospital Choice of Capacity*

Having motivated the presence of an agency problem in the preceding section, I will demonstrate how this agency problem will influence hospital strategy. More specifically, the physician-hospital agency problem may lead the hospital to reduce capacity to a greater degree than it would if the agency problem did not exist.

The model which follows draws upon two models already well received in the health economics literature. The first, by Ellis and McGuire (1986), demonstrates that a mixed reimbursement mechanism is the optimal contract for producing the "correct" incentives for physicians. The second, by Pope (1989), is a theoretical model of a hospital's supply of resources.

#### Characteristics of the Model

- The objective of the model is to examine how hospitals may make strategic choices in their level of capacity in response to managed care and how this may translate into returns for the organization.
- A principal-agent (PA) framework is employed; the hospital is an agent for the HMO (the principal).
- The agent may make an investment (dis-investment) up front that changes the nature of the contract written between the principal and the agent.
- The hospital cannot credibly commit to not employ resources it has available. Because of its imperfect agency relationship with physicians (demonstrated in section 3.2).
- Care delivered in the hospital is a function of the resources available in the hospital.
- The HMO contract with the hospital is a function of the technology chosen by the hospital.

Importance of the model:

- The model is a more real approximation of the choices hospital managers face.

- The model ascribes a strategic action to the hospital rather than treating the hospital as a passive agent simply responding to changes in the structure of the fee schedule faced.
- The model extends the PA literature by 1) showing how the PA relationship between the hospital and the physician affects strategic behavior, 2) allowing for investment by the agent to change the nature of the agency relationship, and 3) placing the agency relationship in a market context.

### General Comments on the Model

The way in which a hospital is paid allows the insurer or payer to regulate the intensity and quantity of services delivered. The ensuing model is similar in some respects to that of Rogerson (1994), who develops a model of how a non-profit hospital selects treatment intensities subject to a payer's choice of prices. He demonstrates that the ratio of price to marginal cost will vary inversely with the elasticity of demand with respect to treatment intensity (where intensity is defined as synonymous with quality) and likens it to longer lengths of stay, more tests, or more aggressive treatment. In particular, he considers the case where the hospital is a multi-product firm and the payer must select a vector of prices for each diagnosis or condition the hospital serves. This changes the nature of the participation constraint from one in which the hospital must earn non-negative profits in each service to one in which the hospital must breakeven overall. The model implies that the hospital will earn positive profits on services with low-intensity elasticities of demand. For the special case in which there are constant returns to scale and production of each service is additively separable, average cost equals marginal cost, and "the result of the paper is that marginal cost pricing never occurs in equilibrium." Further:

> "In the case of a non-profit hospital producing a single medical service the correct course of action is clear. The payer should determine the level of intensity that it feels is appropriate and estimate the hospital's average cost of supplying this level of intensity. If price is set equal to this value of average cost, the hospital will be unable to raise treatment intensity above this level and break even." (1994, p.8,)

This result presupposes that hospitals choose the level of services they deliver. They do so only indirectly. My model extends Rogerson's model by incorporating the physician's preference for hospital inputs. It also adds the important distinction between long-run and short-run equilibrium results, and it allows hospital pre-commitment in capacity to influence the structure of the results.

The model which follows does not assume a necessary alignment of incentives. In particular, we have every reason to believe that physicians are not choosing to maximize hospital objectives (as shown in section 3.2). The model in this paper, while similar to Rogerson (1994) in that the payer chooses prices to induce a desired level of inputs (intensity in the language of Rogerson), differs in that the firm is modeled as a single-service firm with a varying preference toward the delivery of inputs determined by imperfect physician agency. The model assumes no quality competition[17]. Rogerson does not examine the relationship between treatment intensity, as induced by the payer's fee schedule with the hospital, and the corresponding strategic choice of capital the hospital might make in anticipation of the fee schedule set forth by the payer.

The game has three stages. In the first stage the hospital chooses a capacity level, k. Similar to Gal-Or (1994) (k) may have various interpretations depending on what capacity means to the hospital. It may include the number of hospital rooms as well as their allocation to different uses (ICU, rehabilitation, sub-acute care, etc.), capital expenditures on technology or diagnostic equipment, the number of physicians of various types who operate in the hospital, and the size and allocation of staff (primarily nursing) within the hospital. While all these decisions are variable in the long run, in the short run it is assumed that there is a cost to change capacity levels. Furthermore, the choice of capacity is at least partially observable to the HMO and signals the intensity and potential cost of care delivered by the hospital. If the hospital chooses a high capacity level k, this affects the marginal cost of services delivered. In stage 2 the HMO chooses a payment structure and writes a contract with the hospital. The contract is parameterized by the choice of a fixed payment per patient admitted to the hospital (F) and a variable payment per unit of input delivered (v). As such, this combination may approximate many possible reimbursement scenarios, including full capitation (when $v=0$) and fee for service (when $F=0$). The HMO's choice of F and v determines the equilibrium choice of inputs supplied by the hospital. In stage 3 the hospital chooses the number of inputs (R) it will deliver based on its prior choice of k and the HMO's choice of F, and v.

The HMO is faced with choosing a variable payment level v and a fixed payment level per patient F. It knows that for each v it chooses there will be a corresponding level of R delivered to the HMO patients. The HMO has a desired level of R ($R_{HMO}$ in Figure 3.1) that it wishes to obtain from the hospital. We know

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[17] The model solved with quality competition may be found in the appendix to chapter 3.

that the observed level of R is a function of the variable payment v, as well as the FFS payment p, degree of agency $\theta$, capital level k, and cost of each additional R. If the hospital were to choose a high level of k in the first stage, it could produce more R at a lower average cost. If it chooses a high level of k and the demand for inputs is low, it will have a higher average cost but lower marginal cost. This is shown in Figure 3.1.

As may be seen in the figure, the shape of the SRAC is a function of the hospital's choice of k. There is a corresponding cost-minimizing level of R which may be produced for each k. If we assume for a moment that the hospital has chosen the high k due to the historical preference of FFS payers and their corresponding high level of desired R, it will be more costly to produce a lower level of R. If HMO demand (which desires a lower R) is sufficiently large, it may move the optimal choice of k to a lower level, thereby switching the SRAC from curve 1 to curve 2.

The intuition behind the problem is straightforward. If the hospital chooses a high level of k, it cannot credibly commit to delivering an efficient level of R at a low price[18]. This is true even in the case of a low variable payment. The HMO is assumed to have an optimal level of R which is below the level of R that would be delivered to FFS patients. Capitation or payment through F may be viewed as the HMO's way of transferring financial risk to the hospital and creating an incentive to provide a lower level of R. For hospitals with high capacity (high k) therefore the

HMO will pay more F and less v. Similarly, if the hospital has a low stock of k, the HMO will pay more v and less F in an effort to encourage the provision of hospital inputs R.

The sequence of events is as follows:

**Stage 1)** The hospital chooses level of capital (k)

**Stage 2)** Contingent on the hospital's choice of k, the HMO writes a contract with the hospital for delivery of inputs parameterized by a fixed payment (F) per patient + a variable payment per unit of input delivered (v)

**Stage 3)** Based on the HMO's choice of (F) and (v), the hospital delivers a level of inputs R[19]

Hospitals receive two types of reimbursement, from traditional indemnity insurers assumed to reimburse on a fee-for-service basis and from managed care

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[18] There are a number of possible definitions of efficiency that may be employed. An economy as a whole is said to be efficient if no one may be made better off without someone being made worse off. At the level of the firm however, inefficiency may be defined as either technical, scale, or price inefficient. The notion of inefficiency used here is both scale inefficiency, and price inefficient. Scale inefficiency is defined as the firm not operating at the minimum of its average cost curve. Further with the reduced demand for care by managed care plans it is likely that the combination of capital and labor is inefficient. Price inefficiency is defined by a selection of inputs other than the cost minimizing combination.

[19] Based on this formulation there are two possible simple perturbations of this story. The first assumes that there is no quality competition in the market. This is analogous to the HMO writing a hospital contract with the quantity of patients (q) assumed to be exogenous. Patients in this model do not choose hospitals based on their perception of hospital quality. The second model assumes that patients do choose hospitals based on the quality of the provider and as a result hospital demand (q) is a function of perceived quality. Neither solution represents the true state of demand response to heterogeneous quality among providers. In reality, the solution is likely to fall between these two poles. To the extent that HMOs place constraints on the patient's ability to switch hospitals through explicit constraints on the set of hospitals with which the HMO contracts, the demand response will be limited. Even if the HMO contracted with all providers in the market, the ability of patients in the short run to switch hospitals may be limited by the admitting privileges of their physician.

organizations, which reimburse in a potentially mixed form. Hospitals are assumed to be homogeneous and exhibit constant returns to scale[20].

Let $\alpha$ = percentage of the hospital's demand that is managed care this is assumed to be
exogenous in the short run
$q$ = quantity of patients
FFS insurers pay a price (p) per unit of input delivered (R)
HMOs pay a fixed price per patient (F) + a variable payment per unit of input delivered (v)
where $v < c$
$c(R,k)$ = cost per patient to the hospital of each unit delivered and is a function of k and R
cost is assumed to be the same for all patients
$k$ = hospital's choice of capacity

By assumption $p \geq c > v$
$c > 0$
$\partial c / \partial k < 0, \partial^2 c / \partial^2 k > 0$ Costs are convex in k
$\partial c / \partial R > 0, \partial^2 c / \partial^2 R < 0$ Cost are convex in R

Assume the quadratic functional form of the cost function per patient:

$$c = \rho(k)R + \sigma(k)R^2$$

with $\rho(k) > 0, \sigma(k) > 0$
$\partial \rho / \partial k < 0, \partial^2 \rho / \partial^2 k > 0$ $\rho(k)$ is convex in k
$\partial \sigma / \partial k < 0, \partial^2 \sigma / \partial^2 k > 0$ $\sigma(k)$ is convex in k

This functional representation allows for a very general functional representation of costs as a function of the levels of k and R. This effectively captures the effect of the varying level of k on the marginal cost of producing more R.

The assumption that costs are convex in R is straightforward as well. As a hospital supplies more inputs R, the marginal cost per input increases because for a fixed level of capacity, delivering inputs beyond the cost-minimizing supply of R requires the hospital to incur additional costs to produce R. This may take the form of hiring more staff or paying them overtime. The price paid by commercial indemnity insurers is greater than or equal to the marginal cost, while the variable payment by HMOs is less than the marginal cost.

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[20] The implications for these two assumptions are addressed at the end of stage 3. In short it is possible that

For the sake of generality I assume that hospitals maximize a convex combination of utility in provision of services (R) and profits. This approach has been used previously and is similar in spirit to Ellis and McGuire (1986), Frank and Lave (1989), and Glazer and McGuire (1994). Not-for-profit hospitals may be thought of as being imperfect agents for either patients or physicians. In either case, regardless of who determines the demand for hospital inputs, the hospital is modeled as having a preference, in that its utility is increasing in the provision of inputs which may be viewed as analogous to quality. While this preference for provision of inputs may be a natural outgrowth of a non-profit mission as previously described, any hospital, may be viewed as having an additional incentive to deliver inputs (R) due to the agency relationship between the hospital and the physician. Physicians do not act as perfect agents for the hospital, so ($\theta$)may be interpreted as either the non-profit motivation of the hospital or the degree of imperfect agency arising from the physician's PA relationship with the patient. In this way, the physician's agency relationship is endogenized into the contract between the hospital and the HMO.

For the sake of simplicity the utility function is assumed to be additively separable in R and $\pi$. The hospital's utility function is given by $U(R,\pi)$.

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increasing returns to scale and heterogeneity in the hospital population may support consolidation which may lead

Hospital profits = total revenue - total cost

$$\text{Revenue} = \alpha(F + vR)q + (1-\alpha)qpR$$

$$\text{Cost} = kq + \rho(k)R - \sigma(k)R^2q$$

Assume for the purpose of simplicity without loss of generalization that $q = 1$.

Profits, therefore are $\pi = \alpha(F + vR) + (1-\alpha)pR - (k + \rho(k)R + \sigma(k)R^2)$

$$U(R, \alpha(F + vR) + (1-\alpha)pR - (k + \rho(k)R + \sigma(k)R^2)) \quad (6)$$

The hospital therefore maximizes $U(R, \alpha(F + vR) + (1-\alpha)pR - (k + \rho(k)R + \sigma(k)R^2))$
*wrt* R

The FOC wrt R yields

$$\theta U_R + (1-\theta)U_R(\pi) = 0 \qquad (7)$$

$$\theta U_R + (1-\theta)(\alpha v + (1-\alpha)p - (\rho - 2\sigma R)) = 0 \qquad (8)$$

$$\theta U_R + (1-\theta)q(A - \rho + 2\sigma R) = 0 \qquad (9)$$

where $A$ = weighted average price = $\alpha v + (1-\alpha)p$,

$$\text{which yields } R = \frac{A-\rho}{2\sigma} + \frac{\theta U_R}{(1-\theta)2\sigma} \qquad (10)$$

The first righthand-side term equates marginal benefit (in terms of additional revenue per unit of R through A) and the marginal cost parameters $(\rho,\sigma)$ that determine the form of the cost function. As the weighted average price increases (through increases in either p or v), the supply of R increases. If the rate of increase in cost per unit R, $\rho$, is large, the supply of R will be less; similarly, if the rate of change in cost per unit of R becomes increasingly convex $(\sigma \rightarrow +\propto)$, the supply of R decreases.

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to an observation of increasing size and capacity in a subset of hospitals.

The second righthand-side term defines the utility the hospital or physician as agent derives from providing the inputs R. In the case of a for-profit hospital and perfect agency, $\theta = 0$, and this term drops out. The $\theta$ weights are a complex function of the interaction between doctors, patients and hospital management; the various agency relationships will determine $\theta$, as discussed previously in section (3.2). To arrive at a closed form solution I will assume that the marginal utility per unit of R, $U_R$, is constant. This is reasonable when physicians derive a constant additional unit of income per unit of R they choose in the hospital's production function. As $\theta$ increases toward 1 the magnitude of the second term increases, leading to a greater the supply of R. It is worthwhile to note that the choice of v or p by insurers has no effect on this portion of supply of R[21].

If the hospital is NFP or agency is not perfect ($\theta > 0$), the hospital will have an added incentive to deliver R beyond what the HMO would desire for a given level of v in the absence of the hospital deriving utility from the provision of R. In this case the HMO will reduce its payment of v* as $\theta$ increases. In the presence of imperfect agency the hospital has an added incentive to deliver R, so the HMO will have to reduce its level of v* to achieve the same level of R output as in a FP hospital.

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[21] A natural extension to this model would be to incorporate an explicit characterization of $\theta$ as a function of the prices paid to physicians in the hospital model.

Comparative Statics:

**Change in hospital output per unit rate of change in marginal cost**

$$\partial R/\partial \sigma = \frac{-1}{2}\left(\frac{A-\rho}{\sigma^2}+\frac{\theta U_R}{(1-\theta)\sigma^2}\right) \quad (11)$$

As can be seen from the characterization of R, σ enters the hospital's valuation of profits as well as the marginal utility of delivering R. This quantity is negative.

**Change in hospital output per unit change in marginal cost**

$$\partial R/\partial \rho = \frac{-1}{(2\cdot\sigma)} \quad (12)$$

This is negative, suggesting that an increase in the unit change in marginal cost decreases the delivery of R.

**Change in hospital output per unit change in capacity**

$\partial R/\partial k = R_{\sigma}\cdot\sigma_k + R_{\rho}\cdot\rho_k$

$$\partial R/\partial k = \frac{-1}{2}\left(\frac{A-\rho}{\sigma^2}+\frac{\theta U_R}{(1-\theta)\sigma^2}\right)\sigma_k - \frac{1}{2}\frac{\rho_k}{\sigma} \quad (13)$$

Here A = weighted average price and $U_R$ = constant marginal utility.

The term within the brackets is similar to the hospital's choice of R except σ enters squared in the denominator. A change in k has two effects, through ρ and σ. The first term is the marginal effect of a change in k through σ, while the second is the marginal effect attributable to a change in ρ. Based on the assumption of the convexity of each of the cost parameters in k, both terms will be positive, suggesting that increases in the level of capacity will lead to greater intensity or provision of hospital inputs.

**Change in hospital output per unit change in HMO %**

$$\partial R/\partial \alpha = \frac{1}{2}\cdot\frac{(v - p)}{\sigma} \qquad (14)$$

This expression is negative, since $\sigma > 0$ and $v < p$ by definition, implying that increasing HMO penetration decreases inputs delivered by the hospital per admission.

**Change in hospital output per unit change in marginal HMO payment v**

$$\partial R/\partial v = \frac{1}{2}\cdot\frac{\alpha}{\sigma} \quad (15)$$

This expression is positive, since $\sigma > 0$, which implies that by increasing v, the HMO's variable payment, there will be an increase in the inputs delivered.

**Change in hospital output per unit change in hospital preference**

$$\partial R/\partial \theta = \frac{U_R}{2(1-\theta)\sigma}\left(1+\frac{\theta}{(1-\theta)}\right) \qquad (16)$$

Since, by assumption, $1 \geq \theta$, both terms are positive, increases in the degree of imperfect agency lead to a greater supply of R. Again note that prices paid to the hospital by either FFS or HMO payers have no effect on the supply of inputs due to agency relationships or non-profit motives.

### HMO problem in stage 2

The HMO is assumed to contract with those hospitals which produce the highest level of utility for its beneficiaries. The hospitals will supply the desired level of R ($R^*$) at the lowest cost. The hospital's cost is given by its average cost function, which is in turn a function of the k it chooses.

$$AC = k^* + \rho(k^*)R + \sigma(k^*)R^2 \qquad (17)$$

The HMO is assumed to write contracts with the hospital such that the hospital breaks even over all its patients[22].

If not all hospitals are at the most efficient point k* on the AC curve, then the HMO will contract with the most efficient hospital. All hospitals in the first stage of the game will choose k* (so long as there is excess capacity, implying that not all hospitals get contracts), because this will increase the probability that the hospital will get an HMO contract. This does not mean that the HMO will necessarily set the price it pays (F,v) equal to the marginal cost of HMO patients, however, due to the presence of the FFS indemnity payers. If the hospital has a significant portion of its demand accounted for by FFS payers, it will have an incentive to supply a high level of R to meet the demand schedule of the FFS payer. In this case the HMO will pay a lower v and make up any shortfall with an increase in the fixed payment F.

This logic allows me to assume that all hospitals will strive to choose a cost-minimizing level of k in anticipation of the HMO's choice of R in the second stage[23]. They may not choose k*, however, due the presence of FFS patients. The hospital must balance the level of capital desired by FFS patients with the lower level of capital required to deliver the lower level of hospital inputs to the HMO patients. A hospital with a high FFS population may not be able to reduce its level of capacity sufficiently to be cost competitive. Only as the HMO percentage increases in the hospital may it be able to reduce capital sufficiently to compete. This may be an underlying reason for HMOs concentrating admissions in a single hospital aside from the market power effect. A hospital cannot efficiently deliver two levels of service from the same production function. A hospital with a high FFS percentage would have a higher total price and require greater payment in fixed form (F) than in per unit form (v), whereas hospitals with high HMO percentages would have lower total prices, a higher per unit payment (v) and a lower fixed payment (F). It remains to be proven whether as HMO percentage tends toward 100% the hospital is paid completely in variable form (v) but at a lower level due to the reconstituted production function.

---

[22] This is the participation constraint. While this is a necessary condition, it may not be sufficient; it may be the case that hospitals must break even on their HMO patients. This more restrictive constraint is left as an extension to this analysis.

[23] The k* chosen by the hospital should reflect each hospital's existing preference for the provision of hospital inputs or quality. Hospitals which have imperfect agency problems may have to choose a k*-e to achieve the cost-minimizing level of capacity given their preference for the delivery of inputs.

Thus the HMO's problem can be modeled as choosing $R^*$ from the short-run average cost (SRAC) for R for which there is an associated efficient level of k. Any level of $R^*$ can be achieved by paying the average cost, since F is a viable instrument to make up any deficiencies in the required marginal payment.

| | |
|---|---|
| Total Benefits | $R - \beta R^2$ |
| Costs | $(F+vR)$ |

Benefits to the HMO are assumed to be quadratic in inputs. They therefore increase as a function of the inputs, but at a decreasing rate, $\beta_R > 0$, $\beta_{RR} < 0$. This concavity assures an interior solution. When implicitly choosing R through its payment mechanism (F,v), the HMO knows that, for any capital endowment k, there is a cost-minimizing level of R that may be produced by the hospital. In equilibrium, the level of $R^*$ will be equal to a weighted combination of the utility derived from producing R and the weighted average price of the FFS and HMO payers. It is also important to note that since the participation constraint assures that the hospital must break even over all patients, that there is an effective subsidy from the FFS insured patients to the HMO patients. From the hospital's perspective any change in delivered R attributable to HMO patients ($HMO_R$) must be traded off against the impact this has on the level of R delivered to FFS patients ($FFS_R$).

HMOs therefore maximize the following problem to maximize consumer surplus[24]:

$$\underset{wrt\ R}{\text{Max}} \quad R - \beta R^2 - (F(R) + v(R)R) \qquad (18)$$

The first order condition for maximization is therefore

$$\partial\pi/\partial R = 1 - 2\beta R - F_R - v_R R - v = 0 \quad (19)$$

subject to the participation constraint that hospitals must earn non-negative profits on their patients as a whole (including both HMO and FFS patients).

$$\text{Hence } \alpha(F + vR) + (1-\alpha)pR - (k + \rho(k)R + \sigma(k)R^2) \geq 0.$$

The constraint will bind when $F = \frac{\sigma}{\alpha}\cdot R^2 + \frac{(-\alpha\cdot v - p + p\cdot\alpha + \rho)}{\alpha}\cdot R + \frac{k}{\alpha}$

Differentiating the constraint with respect to R to obtain $F_R$ yields

$$F_R = \frac{2\sigma R + \rho}{\alpha} - v_R R + \frac{\left(-\alpha v - (1-\alpha)p\right)}{\alpha} \qquad (20)$$

Substituting $F_R$ into the FOC for surplus maximization with respect to R yields:

$$\partial S/\partial R = 1 - 2\beta R - \left[\frac{2\sigma R + \rho}{\alpha} - v_R R + \frac{\left(-\alpha v - (1-\alpha)p\right)}{\alpha}\right] - v_R R - v = 0 \qquad (21)$$

---

[24] I assume throughout that the objective of the health plan or HMO is to increase consumer surplus. The market structure as well as potential for-profit nature of the HMO will determine the distribution of the surplus.

which simplifies to

$$\partial S/\partial R \;=\; 1-2\beta R-\left(\frac{p(1-\alpha)-(\rho+2\sigma R)}{\alpha}\right)=0 \qquad (22)$$

This equation specifies the relationship between the marginal benefit of an additional unit of R to the HMO (1 - 2βR) and the marginal cost to the HMO of an additional unit of R, given that the hospital must break even overall generating a potential cross-subsidy from the FFS insurers.

The marginal cost to the HMO for an additional unit of input is

$$\left(\frac{p(1-\alpha)-(\rho+2\sigma R)}{\alpha}\right)$$

The first term is the marginal revenue the hospital receives from FFS insurers for each additional unit of R delivered, while the second term is the marginal cost to the hospital for each additional unit of R delivered. As a result, this term in its entirety, from the HMO's perspective, is the *adjusted marginal cost of providing an additional unit of R to the HMO patient.* This adjusts the HMO's cost by the size of the cross-subsidy from FFS insurers.

The HMO will choose v in such a way that it elicits the desired level of R. Therefore there exists a v* and F* such that the HMO will receive its desired level of R from the hospital. The fixed payment F ensures that the hospital will break even and compensates the hospital for any shortfalls which arise from the variable payment v, after accounting for the FFS cross-subsidy.

It is also instructive to see how the equilibrium level of R chosen by the HMO will vary with the managed care percentage ($\alpha$) in the hospital.

The sign of $\partial R^*/\partial\alpha$ is the opposite of $\partial S/\partial R\partial\alpha$[25] =

$$\frac{(\rho+2\sigma R)-(1-\alpha)p}{\alpha^2}-\frac{p}{\alpha}=0.$$

which may be simplified to:

$$\partial R^*/\partial\alpha = \rho + 2\sigma R - p \qquad (23)$$

If $\rho + 2\sigma R > p$, MC > $P_{FFS}$, then $\partial S/\partial R\partial\alpha > 0 \rightarrow \partial R^*/\partial\alpha < 0$.

If $\rho + 2\sigma R < p$, MC < $P_{FFS}$, then $\partial S/\partial R\partial\alpha < 0 \rightarrow \partial R^*/\partial\alpha > 0$.

When the price paid by FFS insurers is greater than the MC of production, there will be a cross-subsidy to the HMO patients. Furthermore, the difference between the FFS price and MC or production positively affects the level of R chosen by the HMO. As the HMO percentage increases, however, the FFS percentage decreases, and the value of the subsidy decreases. In the limit, the overall FFS surplus (a function of the level of p) will asymptotically approach the MC of production. The will lead to a reduction in the level of R chosen by the hospital.[26]

### Stage 1 - Hospital solution for choice of capital k

In stage 1 the hospital chooses its level of k, assuming levels of F and v, which were chosen based on the hospital's production of R[27]. The hospital solves an identical maximization problem as in stage 3 but solves with respect to its choice of k. The objective of stage 1 is to show that hospitals choose $k^*(R^*)$ and that $\partial k^*(R^*)/\partial\alpha$ is less the greater the HMO penetration in the hospital. The hospital chooses **k*** **in an effort** to maximize the likelihood of getting an HMO contract; this effectively results in the hospital choosing a k* that maximizes the HMO's utility.

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[25] The second derivative of the surplus function $\partial S/\partial R$ is negative and equal to $-2\beta - 2\sigma/\alpha$.

[26] The level of p is therefore shown to be important in determining the level of R chosen or desired by the HMO. The level of p, while not modeled specifically in this analysis, is a function of the market structure for hospital services as well as the construction of the FFS plan.

The choice of k by the hospital may then be viewed in light of the effect of a change in k on the marginal benefit to the HMO. This problem may be solved by letting the HMO choose the hospital's level of capacity k. The effect of a change in k on the level of R demanded can be ignored because the HMO surplus function has already been maximized with respect to R[28].

The HMO surplus function is given by

$$\text{Max } S = R - \beta R^2 - (F(R) + v(R)R) \qquad (24)$$

Use of the envelope theorem simplifies the analysis to a consideration of the effect of k on the marginal cost of an additional unit of R to the HMO. This is simply $F_k + v_k{}^*R$.

Using stage 3, it is possible to obtain both F and v. The variable payment made by the HMO per unit of R may be obtained from R in stage 3 and is equal to

$$v = 2\frac{R}{\alpha}\sigma(k) + \frac{\left(-p + p\alpha + \rho(k) + \theta\frac{U_R}{-1+\theta}\right)}{\alpha} \qquad (25)$$

$$v_k = \frac{\rho_k + 2\sigma_k R}{\alpha} \qquad (26)$$

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[27] The hospital's production of R is the sum of the demand by FFS and HMO plans.

[28] This is the envelope theorem.

The numerator is the marginal cost per unit change in k, and the denominator is the hospital's HMO percentage. F may be obtained by using v in the hospital's profit function and setting it equal to zero. The fixed payment F is the amount necessary to ensure that the hospital profit function is equal to zero.

$$\mathrm{F} = -\frac{\left(\sigma(k)R^2 + R\theta\frac{U_R}{(-1+\theta)} - k\right)}{\alpha} \qquad (27)$$

$$\mathrm{F}_k = \frac{1-\sigma_k R^2}{\alpha} \qquad (28)$$

Using the partial expressions for the effect of k on F and v in the HMO's surplus function yields

$$-\left(\frac{1-\sigma_k R^2}{\alpha} + \frac{\rho_k + 2\sigma_k R}{\alpha}R\right) = 0 \qquad (29)$$

which may be simplified to $-1 - \rho_k R - \sigma_k R^2 = 0$. This implicitly defines the choice of k*.

From this expression it is then possible to obtain the effect of increasing HMO penetration on the level of k* in the hospital:

$$\partial k/\partial\alpha = \frac{-\left(-2\sigma_k R R_\alpha - \rho_k R_\alpha\right)}{\left(-\sigma_{kk}R^2 - 2\sigma_k R R_k - \rho_{kk}R - \rho_k R_k\right)} \qquad (30)$$

Given that $\sigma_k$, $\rho_k$ and $R_\alpha$ are $< 0$, the numerator is negative. The denominator is simply the second-order condition, which must be negative to ensure concavity. This condition will hold if the marginal effect of additional units of capacity k drops off rapidly. More specifically, if

$\sigma_{kk}R + \rho_{kk} > 2\sigma_k R_k + \frac{\rho_k R_k}{R}$. This implies that the sign of $\partial k/\partial \alpha$ is negative, suggesting that an increase in HMO penetration leads to a reduction in hospital capacity.

It is important to note the implications of this result for the larger population. It is likely that the population of hospitals is heterogeneous in cost functions, and there may significant economies of scale. While in aggregate we are likely to see a reduction in hospital capacity in response to increasing HMO penetration, it may well be the case that consolidation among hospitals may be part of a capital adjustment process leading to increases in the size, capacity and level of capital in any particular hospital.

### Implications

The models demonstrate the role of monitoring and direct capacity reduction in response to managed care penetration. The first model demonstrates the physician's preference to deliver hospital inputs because her or she is not contractually bound to the hospital and responds to the incentives set forth by his or her fee schedules. The hospital must engage in monitoring to constrain the physician's use of hospital inputs. As the hospital's HMO percentage increases, the proportion of demand requiring a lower level of inputs increases, and the cross-subsidy from FFS insurers decreases. As a result, the hospital must increase its efforts to constrain the delivery of inputs. This may take two forms: monitoring, as identified in Section 3.1 or directly reducing the availability of inputs, as demonstrated in Section 3.2.

Monitoring and capacity reduction may both be employed to achieve the same desired outcome, the delivery of hospital services with a lower level of hospital inputs. In addition, the model demonstrates that, as the agency problem or the hospital's revealed preference toward the delivery of inputs increases, the hospital must either engage in more monitoring or undertake a greater reduction in capacity to achieve the same desired lower level of R[29].

Non profit hospitals have historically attracted physicians by providing services or inputs which the physician values. Thus, these hospitals are more likely to have higher levels of available inputs and capacity. The model in section 3.2 explicitly models the NFP hospital as having a preference for the delivery of hospital inputs. As a result, NFP hospitals may have to adjust their stock of capacity to a greater extent than FP hospitals to configure their organizations to meet the evolving demand from HMOs.

Capacity reduction and the hospital's level of monitoring may be viewed as substitutes. A potential difference between the two methods is that it may be difficult for the hospital to target capacity reductions specific to the HMO segment of demand as reducing the level of capital assets is likely to affect the level of service available to all patients in the hospital. Effective monitoring may more easily target those patients for whom the hospital receives a capitated payment. Fee-for-service patients still desire a higher level of service. This argumentation affords the ability to test not only the difference in behavior between FP and NFP hospitals but also the difference in the use of monitoring and capacity reduction in response to increases in managed care demand.

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[29] This assumes that NFP hospitals wish to take on managed care business in the first place. This is not necessarily a forgone conclusion, if the NFP hospital's preference for quality or delivery of hospital inputs / quantity is so great that HMOs would not contract with at all.

Figure 3.2 graphically depicts the hypothesized relationships implied by the preceding theoretical discussion. There are four theoretical constructs: hospital action, hospital monitoring, hospital HMO%, and hospital performance. These four constructs translate into four equations, and the depicted inter-relationships among the constructs test hypotheses regarding:

- The level of response to managed care percentage
- The type of response chosen by the hospital (capacity reduction / monitoring)
- The effect of these choices on subsequent HMO demand
- The joint effect of these decisions on hospital performance.

Figure 3.2 is a useful representation of the system of relationships among the theoretical constructs. The arrows between the constructs indicate the direction of the effects. Beside each arrow (1-4) is a number indicating the equation in which the hypothesis will be tested in Chapter 4. Each individual arrow is lettered sequentially (A-J), they correspond to the 10 general hypotheses[30].

## Hypotheses

*Hypotheses suggested by the model*

**H.A.1)** Increases in HMO penetration reduce the level of resource-intensive hospital services.

The logic is straightforward. If HMOs did not desire a different service configuration from that historically delivered by hospitals to traditional indemnity insurers there would be no effect. By assumption HMOs desire a lower level of inputs. Thus each of the 11 potential actions estimated in the empirical section differs with respect to its degree of inputs. Increasing HMO penetration will lead a hospital to reduce capacity and intensity.

> **H.A.2)** For-profit hospitals respond less to HMO penetration than NFP hospitals.

While the theory is ambiguous on this point, it may be that NFP hospitals, in part due to physician agency and in part due to their mission, will need to reduce their level of resource-intensive services through changes in actions to a greater degree than FP hospitals. For-profit hospitals may already be configured more consistently with the efficient production of services at a lower level of inputs because they do not have an explicit preference for the provision of inputs. This, however, is more an argument about levels than percentage change, and as a result it is possible that both NFP and FP hospitals change the same percentage in response to HMOs, with FP hospitals just starting from a lower level.

This is not to say, however, that FP hospitals are free from the imperfect physician agency problem. The greater the agency problem in FP hospitals, the greater the need for these hospitals to control this problem when faced with HMO demand. In this analysis, however, due to the inability to quantify the degree of imperfect physician agency, NFP hospital status will be used as a proxy for the degree to which the hospital will have to adjust its production process.

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[30] More specific formulations of these general hypotheses will be presented in Chapter 4.

**H.B.1)** Increases in monitoring increase the supply of resource-intensive services. (complementary hypothesis)

**H.B.1.A)** Increases in monitoring decrease the supply of resource-intensive services (substitution hypothesis)

If monitoring is an effective means of constraining the delivery of hospital inputs, an increase in the level of monitoring may reduce the need for the hospital to constrain inputs by rationing services. At the same time, however, the presence of a high level of monitoring may allow the hospital to expand its provision of resource-intensive services but constrain their use to only FFS patients.

**H.B.2)** For-profit hospitals will adjust their level of monitoring less than NFP hospitals in response to managed care penetration.

The logic for this hypothesis is similar to that of H.A.2. In addition, FP hospitals are more likely to employ financial incentives for management tied to operational performance. This is a natural outgrowth of their FP motive.

**H.C.1)** Hospital reductions in resource intensive services and shifts to less resource-intensive services increase the hospital's HMO percentage.

Hospitals that reconfigure their services and delivery process consistent with the preferences of the managed care firm are more likely to receive HMO patients.

**H.C.2)** For-profit hospital action will have less of an impact on HMO demand than will not-for-profit action.

For the reasons already stated, for-profit hospitals are more likely to have their organizations configured in such a way that they deliver a cost-effective set of inputs.

As a result, on the margin, adjustments made by FP hospitals are likely to have less of an effect on HMO demand.

> H.D.1) Increases in monitoring increase the hospital's HMO percentage.

To be in a position to accept HMO contracts and deliver a lower level of inputs the hospital must have a mechanism in place to ration the delivery of inputs. Thus, hospitals that increase their monitoring staff are more likely to accept managed care patients.

> H.D.2) The response of HMO demand in the hospital is less for FP hospitals than for NFP hospitals.

A requisite condition for hospitals to accept managed care patients is to have a monitoring mechanism already in place. Monitoring is more important in the NFP hospital due to the presence of a higher level of inputs available for the physician to prescribe and deliver. As a result, the impact of monitoring on HMO demand for FP hospitals is likely to be less than for non-profit hospitals.

> H.E) Increases in a hospital's HMO percentage increase monitoring.

For similar reasons as hypothesis H.D.1.

> H.F) Reductions in hospital levels of assets which are resource-intensive reduce the level of monitoring.

If capacity reduction and monitoring are substitutes, the use of one mechanism to reduce the level of available or free resources will reduce the need to employ the substitute mechanism.

H.G.1) Hospital action (adjustment of hospital capacity) will reduce performance for traditional patients.

H.G.2) Hospital action increases organizational performance for HMO patients.

A hospital that changes the availability of inputs for traditionally insured patients will result in lower performance for non-HMO patients. This is based on the assumption that the configuration of hospital capacity is such that the hospital is operating at the minimum of SRAC for FFS patients. In short, the hospital is in equilibrium and optimally configured given the prior demand for services.

At the same time, however, for the portion of the hospital's demand accounted for by capitated patients, the hospital is likely to perform better. The hospital must trade off the effect of reductions in capacity on the demand and subsequent performance of both the indemnity patients and the managed care patients.

H.H) Monitoring increases hospital performance.

Regardless of the proportions of HMO and indemnity patients, the presence of monitoring is likely to ensure that an efficient level of resources will be delivered to the patient. For indemnity patients, to the extent that the hospital is compensated for additional services, monitoring may increase the level of services to indemnity patients. For HMO patients the effect is just the opposite, and the rationing of inputs through monitoring will increase hospital performance.

H.I) Increases in HMO percentage decrease hospital performance.

To the extent that the managed care organization can transfer financial risk to the hospital and set a price approximating the hospital's marginal cost of production, the hospital will experience diminished operating margins compared with traditional indemnity insurers and Medicare patients.

## Appendix 3.1 Model Extensions

This is a very general model of hospital contracting with HMOs. It has a couple of unique features that suggest several potentially fruitful extensions. First, it endogenizes the physicians' behavior to the HMO contract with the hospital. This could be representative of a general class of models in which a principal contracts with 2 agents independently who are jointly responsible for producing a given output. The parameter $\theta$ captures the hospital's valuation of production of inputs in and of itself. This is motivated by the fact that physicians act as imperfect agents for both the hospital and the patient and are motivated by their own reimbursement schedule; they thus have an incentive to deliver inputs without consideration of their cost to the hospital. A logical extension would be to include the physician's objective function as a maximand in the hospital's objective function. This would not only more explicitly capture the nature of the physician's incentives and how they relate to the hospital, but also may be justified on the grounds that hospitals actively compete for physicians by increasing their utility.[31] This model demonstrates that in the presence of complete information – the hospital's action taken in stage 1 is perfectly observed by the HMO – the HMO is able to tailor the form of its contract so that hospitals are guaranteed to make zero profit. This would change if either the HMO could not perfectly observe the hospital's investment in stage 1 or the HMO was constrained to write a single form of contract with multiple providers. Thus, the model just presented, while demonstrating a plausible contracting arrangement between HMOs and hospitals, is not particularly interesting. Only in the presence of informational asymmetries or single-form contracts may the hospital win or lose on the HMO contracts. If I assume for a moment that the HMO cannot perfectly observe the hospital's cost function or cannot perfectly differentiate its contracts across hospitals, the HMO will have an incentive to affect the agency relationship the physician has with its patients.

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[31] For the empirical part of the analysis $\theta$ will be treated as a NFP dummy variable. This is due to the lack of data on the degree of physician agency. In future work incorporation of such data would be valuable.

Figure 3.1:Change in Short-Run Average Cost Curves with HMO Penetration

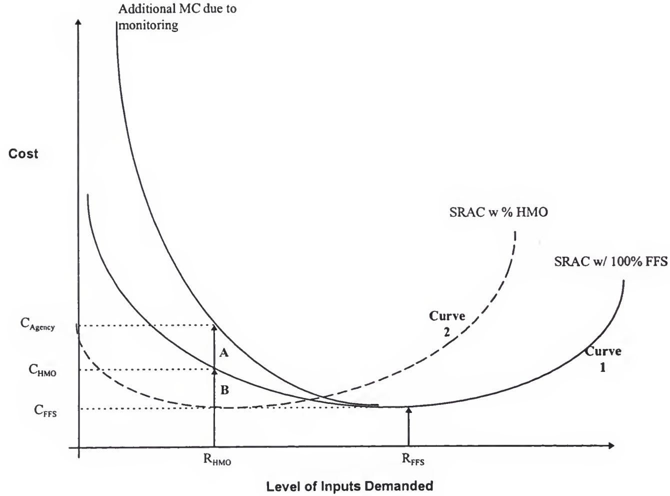
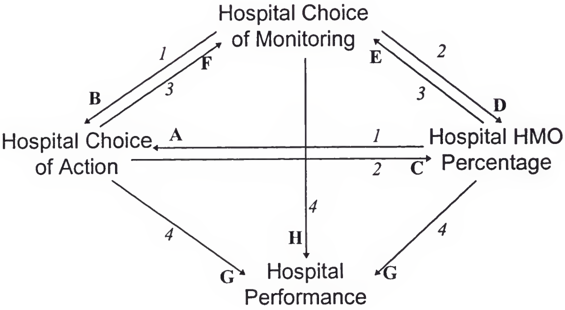


Figure 3.2: Diagrammatic Representation of Equation System



**Note:** Numbers represent equation number in simultaneous system. Arrows indicate direction of effect. Letters correspond to chapter hypotheses.

# Chapter 4: Research Design & Estimation Strategy

Health care markets in the state of Florida evolved at a rapid pace in the late 1980s and early 1990s. There are unique characteristics about the Florida population as well as health care markets which have implications for the empirical analysis as well as the generalizability of the results.

The population in Florida is unquestionably older than in many other states due to the preponderance of retirees. This fact alone may have important implications for this analysis as well as the generalizability of these results to other states. First, the population of the state is likely to have a greater demand for health care services, as health care demand is positively correlated with age. Furthermore, older patients are likely to have a need for more acute high-cost services. This may limit the hospital's ability to retire resource intensive services such as intensive care beds. In addition, this population is insured through Medicare. Hospitals in the state have particularly high Medicare percentages, averaging 45% in 1989, and the mean Medicare percentage grew by approximately 7% to 48% in 1993.

The predominance of Medicare as a payer for hospital services may reduce the impact of commercial managed care[32] on hospital behavior. The theoretical model demonstrates that the aggressiveness of managed care in constraining the delivery of hospital inputs, R, is a function of the size of the cross-subsidy available from non-managed care payers. If the price of FFS is significantly higher than marginal cost, the HMO will effectively choose higher levels of R through its payment of v and F.

Because the hospital will use proceeds from the non-managed care patients to subsidize the managed care patients. If, however, the other non-managed care payers are paying close to marginal cost, there will not be a significant cross-subsidy to the HMO patients. This effectively increases the price of R to the HMO, resulting in a reduction in demand for hospital inputs. During this time period, Medicare was sufficiently stringent that hospital operating margins were relatively low. Without a large subsidy pool, the HMO effect will be less; the HMO will consistently demand lower levels of inputs. This dampens the hospital response to increases in managed care penetration. Any response to managed care that is detected in the Florida data is therefore likely to be a lower bound on the response seen in populations with a lower percentage of elderly patients or more generous FFS reimbursement rates.

Florida has been the site of tremendous activity in both managed care and hospital markets. Preliminary analyses were performed on study variables to ensure that there exists sufficient variability in managed care penetration over time and across markets. Table 4.1 demonstrates that there is significant variation in HMO% by market area and over time. In 1989, 4 markets had no managed care penetration, while in 1994 only 1 market (Naples, FL) had none. The mean increase in HMO% over the study period was 11%, ranging from 0% in Naples to 35% in Fort Lauderdale. This assures longitudinal as well as cross-sectional variation to examine the extent to which there is a differential response by hospitals to increasing HMO penetration.

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[32] During the study period, Medicare managed care had not gained a significant foothold in the market.

Table 4.2 demonstrates the variation that exists across hospitals within metropolitan service areas. It is informative to see that in reasonably large MSAs there exists significant variation in the hospital HMO penetration (1994 standard deviation 0% - 35%). Additionally, there appear to be some hospitals with very high HMO percentages. The extent to which these hospitals respond differently and the extent to which this is manifested in their financial performance is the focus of this investigation.

The ensuing discussion describes the data sources, definition of hospital markets used in this study, definition of competition, definition of the sample, variables, and specification of the econometric models.

### *4.1 Data Source*

Audited financial statements have been obtained from the Florida Agency for Health Care Administration (AHCA) for the period 1989-1994[33]. These facility-level financial reports include organizational attributes, dimensions of service delivery, payer shares, information on service line staffing and capital investment, as well as financial information included on balance sheets, statements of cash flows, and income statements. These data are used to characterize the actions taken by hospitals in response to increasing managed care penetration, as well as their subsequent financial performance during the study period. To control for significant market-level effects, which will influence the demand for hospital services, per capita income, unemployment rate, physician population ratios, population density, median age, and median education are drawn from the Area Resource File (ARF) compiled by the Bureau of Health Professionals.

The Florida hospital sample includes all short term, non-federal acute care hospitals which reside in an MSA and for which data was present for the six year period. This yielded a sample of 123 hospitals[34].

## *4.2 Hospital Markets and Competition*

### 4.2.a Definition of Hospital Markets

The definition of the hospital market employed in this research is the metropolitan service area (MSA) in which the hospital resides. Numerous definitions of hospital markets exist and may largely be delineated as either geopolitically or patient-flow defined. Each definition has strengths and weaknesses. There is no reason a priori to believe that geopolitically defined boundaries will bear any resemblance to the actual patient flows in the market, as patients often cross county boundaries when seeking care. Furthermore, when hospitals think about actions they take, they do not limit their consideration set to only those hospitals which reside in their county. However, geopolitical boundaries have the benefit of being exceedingly easy to quantify.

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[33] Additional years of data were unsuitable for analysis. Prior to 1989 Florida did not differentiate hospital payer status sufficiently to identify managed care penetration in the hospital. In 1995, approximately 60 hospitals filed suit against the AHCA and as a result have not submitted their data. This non random response bias precludes analysis of calendar year 1995.

[34] There is the potential for a survivor bias to be introduced as a result of constructing the sample from hospitals which were present during the study period. This may mean that the hospitals upon which the estimation is conducted differ systematically from the underlying population. Since managed care has just recently entered the market however it is unlikely that the increasing managed care penetration was the precipitating event.

Phibbs and Robinson (1993) incorporated regional characteristics to construct a hospital radius, which would capture either 75% or 90% of the hospital's admissions. All hospitals within this radius or service area were viewed as competitors, and two measures, the number of hospitals and an HHI based on hospital bed shares, were proposed as extensions of the popular 15-mile radius definition of hospital markets (Luft & Maerski, 1984; Luft, et al., 1986; Robinson & Luft, 1985; Robinson & Luft, 1988). Morrisey, Sloan and Valvona (1988) used patient origin data to construct markets that took into account the potential for patients to leave market areas and obtain health care elsewhere and for patients to enter the market area to obtain service. This approach, which capitalized on the industrial organization and antitrust literature, defines a market when patient inflow and outflow are arbitrarily small. It iteratively forms and amends hospital inclusion in markets until the patient inflow and outflow reaches a predetermined level (See Morrisey, Sloan and Valvona, 1988). This has the somewhat more desirable quality of not splitting hospital markets based on counties.

Approaches based on patient flows suffer from two potential weaknesses. First, the definition of the market is endogenously determined by the hospital's strategy and as such could be viewed as a strategy unto itself. It does not capture the potential market, which may fundamentally change with the introduction of managed care. Second, the calculation of such markets is non-trivial. The iterative techniques required are at times sensitive to the starting seed hospital, and they require tremendous computational resources[35].

This thesis employs the MSA as the definition of the hospital market for three reasons. First, a guiding theme and focus of this analysis is how hospitals are responding to managed care firms. There is no reason to believe that managed care firms will respect a hospital's enacted market when selecting the hospitals with which they contract. It is also conceivable that as HMOs engage in selective contracting they may force patients to travel to providers which other than the hospitals closest to their residence. Hospitals therefore must broaden their consideration of potential competitors and the market in general. HMOs are in part concerned with the geographic coverage of their network. Second, MSAs are exogenously determined, whereas patient flow measures of hospital markets are in part a function of hospital strategy, as explained above. The definition of competition within these markets is therefore contaminated with the choice of the market definition itself. Finally, and potentially most important, managed care penetration in rural markets is exceedingly low. As a result there will be no change in the principal independent variable of interest.

Thus hospitals not in MSAs have been removed from the sample – due to the low level of HMO penetration in these markets as well as the fact that behavior of rural hospitals introduces an additional set of constraints, issues and strategies

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[35] In a project currently underway with Morrisey and Wedig this technique applied to Illinois patient discharge information required a Cray supercomputer to define markets. This is the second largest computational task the supercomputer at the University of Alabama - Birmingham had ever undertaken.

(Alexander, 1995). The MSA is likely to be reasonably inclusive with respect to HMO contracts, patient choices regarding potential providers, and hospital response. There are 20 MSAs in the state of Florida and therefore 20 markets: GAINESVILLE; PANAMA CITY; MELBOURNE-TITUSVILLE-PALM BAY; FORT LAUDERDALE; PUNTA GORDA; JACKSONVILLE; NAPLES; MIAMI; PENSACOLA; DAYTONA BEACH; TALLAHASSEE; TAMPA-ST. PETERSBURG-CLEARWATER; ORLANDO; FORT MYERS-CAPE CORAL; SARASOTA-BRADENTON; OCALA; FORT PIERCE-PORT ST. LUCIE; FORT WALTON BEACH; WEST PALM BEACH-BOCA RATON; LAKELAND-WINTER HAVEN.

### 4.2.b Definition of Hospital Competition

Studies of hospital competition and market structure have typically been performed to assess the degree to which competition affects cost and quality. Studies conducted prior to the implementation of prospective payment have typically found that increased competition increased the cost of health care due to presumed competition on non price dimensions (Farley, 1985; Luft, et al., 1986; Robinson & Luft, 1985; Robinson & Luft, 1987). Studies since the introduction of PPS have found that competition has reduced hospital costs significantly (Zwanziger & Melnick, 1988).

The aforementioned studies examined the effect of market structure on various hospital characteristics: performance (Farley, 1985), cost per admission (Luft & Maerski, 1985), or probability of offering a service (Luft et al., 1986). The definitions of competition employed differ across the studies as well. Farley used the hospital market's Herschman-Herfindahl Index (HHI)[36] as the measure of competition. Robinson and Luft used the number of hospitals within a 15 mile radius as the measure of competition. Zwanziger and Melnick (Zwanziger & Melnick, 1988) identified competitors as hospitals which drew significantly from the focal hospital's market areas delineated by zip codes. A service-specific HHI was constructed for each zip code area, and an overall HHI was defined as the weighted average service HHI, weighted by the proportion of the hospital's discharges in each service. Consistent with previous research, this thesis uses the HHI within the MSA market boundary as a measure of hospital competition.

## *4.3 Variables*

### 4.3.a Study Variables

The principal study variables are the hospital's action, the hospital's monitoring, the HMO penetration in the hospital, and the hospital's operating margin (a measure of financial performance).

Eleven different changes in hospital actions are examined. These variables were chosen for a number of reasons. First, these decisions are presumed to be variable in the short run. Furthermore, these variables were chosen in an effort to represent choices made by hospital management. Variables such as cost, volume, and number of services delivered are a function of the demand in the hospital and not directly a result of a choice made by hospital management and are therefore unsuitable to an examination of strategic adaptation by hospitals. The three classes of variables are:

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[36] The HHI is the sum of the squared market shares within a market.

- Scope of services (identified by allocation of hospital beds)
- Scale of services (identified by number of beds, number of full time employees)
- Capital investments (identified by purchase or retirement of capital assets)

**Scope:** Allocation of hospital beds to different uses is a signal of the hospital's allocation of resources. Three different models are estimated, corresponding to the percentage of hospital beds allocated to subacute care, the percentage of hospital beds allocated to acute care, and finally the percentage of beds allocated to intensive care services. In each case a change by the hospital represents a cost to the organization (it is costly to create new ICU beds). Also a reduction or increase in each of these areas constrains or enhances the organization's ability to care for patients of particular types. If a hospital has a low supply (percentage) of ICU beds they will have to increase the throughput through the ICU to ensure that the organization may continue to do surgery. Likewise, the presence of lower cost sub-acute beds may signal to the market and the HMO in particular that the hospital delivers a lower level of inputs per patient.

**Scale:** Three different models of hospital scale are estimated: total number of hospital beds, total number of full time equivalent employees (FTE)s and potentially of particular interest to HMOs, the number of FTEs allocated to outpatient settings. Hospitals that reduce the number of employees or beds impose supply-side constraints on the delivery of care and holding demand constant, decrease the fixed cost per patient in the organization. Hospitals that increase the number of FTEs in an outpatient setting may credibly signal to the market that they have the capacity to deliver care in a lower-cost outpatient setting. This may be attractive to HMOs desiring a lower level of inputs to be delivered to their patients.

**Capital Investment:** Five different models of capital investment are estimated: capital disposed as a percentage of total assets, new capital added as a percentage of total assets, a ratio of capital disposed to capital added, capital purchases of new fixed equipment as a percentage of total capital added, and finally capital purchases of new moveable equipment as a percentage of total capital added. Additions or deletions of hospital capital as a whole or of equipment more specifically may directly limit the type and extent of services that are produced in the hospital. To the extent that such decisions are observable in the market they may signal the intention of the hospital to be a low-resource hospital, or they may directly ration the level of inputs to providers practicing in the hospital.

**Monitoring:** As an alternative to imposing supply-side constraints through reductions in capacity, hospitals may choose to increase the level of monitoring. This may have the added benefit of being targeted to HMO patients only, thereby retaining high-intensity service for non-HMO patients. Monitoring is measured as the percentage of hospital staff dedicated to medical care review and medical staff administration.

The role of monitoring is of theoretical importance to this work. In this hospital context there are a number of different types of monitoring that may take place. The hospital may monitor the behavior of the physician with respect to admission practices as well as delivery of hospital inputs once the patient is in the hospital. Hospital utilization review and quality assurance staffs have increased with the presence of managed care, lending *prima facie* evidence for the relationship between managed care and increased monitoring. These staffs, through their clinical auditing of hospital services, provide a direct monitoring function. Administrative staff may also take on a monitoring function as their departmental budgets come under increasing pressure. The accounting department has as its explicit charge the monitoring and reporting of organizational activity. Given the theoretical importance of monitoring in this analysis I attempted to construct the monitoring measure based on multiple dimensions. Given the correlation among many administrative and oversight functions it was not possible to enter them separately in the ensuing models. Furthermore, it is possible that increases in administrative and accounting staff size may be related to increasing complexity in the health care environment as well as the contracts written with the organization, so these were not included in the monitoring measure. The sense of monitoring here is intended to be clinically specific in that the monitoring is targeted to the delivery of medical inputs by physicians.

Monitoring is defined as the sum of the shares of hospital employees which are allocated to medical care utilization and review and medical staff administration. As such it is a composite measure. Both dimensions are believed to capture dimensions of monitoring in the hospital. The justification for percentage staff allocated to medical care review is straightforward; these employees are typically involved in performing chart reviews and auditing the delivery of inputs to assure quality. The percentage of medical staff administration is intended to capture the oversight that may be present from physician leadership in the hospital. An institution with a higher percentage of employees in medical staff administration may be better able to administer the credentialling process and oversee physician behavior in the hospital. The behavior of the monitoring variable is dominated, however, by the medical care review component. The mean of medical care review is 1.1%, and the mean of medical staff administration is .3% with the mean of the monitoring variable is therefore 1.4%. Furthermore, the Pearson correlation coefficient between monitoring and medical care review is .80 and highly significant[37].

The other two study variables of interest are the HMO penetration in the hospital and the operating margin. The hospital's HMO percentage is defined as the percentage of total admissions for acute care services accounted for by commercial HMO patients. This is both an independent variable of interest – the effect of HMO penetration on hospital action – and a dependent variable or response – the effect of hospital action on HMO penetration. Hospital operating margin is a measure of financial performance and again is both a dependent and independent variable in the system of equations. The operating margin may affect both the ability as well as the need for the hospital to adjust its stocks of capacity. In addition, hospital action and HMO penetration may affect the hospital's financial performance.

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[37] The correlation between certain types of administrative staff and medical care review (the most direct available measure of monitoring) were not highly correlated. This supports the supposition that increases in administrative staff may reflect other changes in the hospital environment other than simply the need to monitor or oversee the production function more diligently.

### 4.3.b Market Control Variables

The following market-level variables are included in the analyses: median income, unemployment rate, population density, median number of school years, market HMO%, for-profit market share, multi-hospital system market share, and market HHI (a measure of competition). These variables are sources of exogenous variation in both hospital response and HMO contracting with hospitals. Market-level variables were either obtained from the ARF or computed directly from the data. Median income, unemployment rate, market HMO%, for-profit market share, multi-hospital system market share, and market HHI were treated as time varying while the other variables were fixed during the study period.

Median income values for 1986-1990 and unemployment rate values for 1986-1991 were present in the 1993 ARF. These values were used to obtain predictions for years 1991-1994. Regressions were performed with the resulting equations for 1991-1994 specified as follows:

$\text{Median income}_t = 409 + 1.03631 \text{Median income}_{t-1}$

$\text{Unemp. Rate}_t = 15.812153 + 1.124907 \text{ Unemp. Rate}_{t-1} - 0.223221 \text{ Unemp. Rate}_{t-4}$

Population density is the number of persons per square mile in 1980 and is treated as fixed over the period. Education is again measured in 1980 as the median number of school years for persons over age 25. There are 67 counties in the state. These variables are attributed to the hospital regardless of MSA based on its location in the county.

## *4.4 Methods & Empirical Specification*

### 4.4.a Three-Stage Least Squares

Due to the obvious endogeneity of the hospital's action, choice of monitoring, HMO penetration and financial performance, it is necessary to estimate the four equations simultaneously. A three-stage least squares (3SLS) estimation procedure is therefore employed. In particular, hospital action is a function of monitoring, performance, and HMO percentage in the hospital. In turn, monitoring is a function of hospital action and HMO percentage. The level of HMO penetration is further a function of prior hospital action and monitoring. At the same time, the hospital's ability to engage in a strategic adjustment is a function of its financial ability to do so. This suggests that hospital financial performance affects the hospital's ability to engage in action. Finally, hospital action and HMO percentage affect the hospital's financial performance.

In this system action depends on monitoring, HMO percentage, and the interaction of each with FP status; monitoring depends on action and HMO%; HMO percentage depends on hospital action and monitoring; and finally performance depends on action, monitoring and HMO percentage. Since all four dependent variables are jointly endogenous, the four structural equations are necessary to describe the observed values. The presence of the endogenous variables violates the fundamental assumption of OLS regression that the regressors are uncorrelated with the residual. This leads to parameter estimates that are both biased as well as inconsistent. As a result, none of the four equations may be estimated consistently using OLS. The second problem with this system of equations is that there is contemporaneous correlation of errors across equations, which reduces the efficiency of the parameter estimates. Three-stage least squares remedies these two problems. First, 3SLS uses Y-hat instead of Y for the endogenous regressors; second, 3SLS includes the cross-equation error correlations to improve sample efficiency[38].

The system of equations is identified. For the system to be identified it must satisfy both the order conditions. The order condition states that the number of omitted exogenous variables from each equation must be greater than or equal to the number of endogenous variables. This condition is satisfied in each of the three equations. In fact, the system is over-identified, which means that there are additional constraints placed on the system of equations through the inclusion of the independent variables. The rank condition is usually satisfied and assures that there is a unique solution.

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[38] Full information maximum likelihood has been shown to be more efficient than 3SLS when lagged dependent variables enter the system of equations. In estimating this system of equations, FIML estimation would not converge and did not efficiently search for global maximimum. Hence 3SLS is used. This imposes more structure on the system of equations.

### 4.4.b Partial Adjustment Model

In addition, since I am interested in the adjustment over time in hospital action toward a theoretical optimum[39] and HMO penetration, partial adjustment models are estimated to test the effect of changes in HMO penetration on hospital strategic adjustment and strategic adjustment on HMO penetration[40]. The partial adjustment model is of the general form

$$y_t^* = \alpha + \beta x_t \qquad (31)$$

where y* is the optimal level of each action.

This has been used to describe a rule for optimal inventory level as a function of sales. The model is analogous to the adaptive expectations model and was originally associated with Koyck's (1954) study of investment. "The adjustment of the actual level is a proportion of the difference between this period's desired level and last period's actual level" (Greene, 1993).

$$y_t - y_{t-1} = (1-\lambda)(y_t^* - y_{t-1}) + \varepsilon_t \qquad (32)$$

which is equivalent to $$y_t = (1-\lambda)y_t^* + \lambda y_{t-1} + \varepsilon_t \qquad (33)$$

which states that the current level is a weighted average of the desired level (y*) and the last period's level ($y_{t-1}$). Substituting $y_t^* = \alpha + \beta x_t$ into (3) above yields:

$$y_t = \alpha(1-\lambda) + \lambda y_{t-1} + \beta(1-\lambda)x_t + \varepsilon_t \qquad (34)$$

Rearranging yields the moving average or distributed lag form

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[39] The hospital should be moving their stock of capacity to the new k* which will deliver $R_{HMO}$ at the minimum of the LRAC including HMO demand. Remember that this may be less than the actual k* without any imperfect agency.

[40] Hospital monitoring and financial performance are assumed to adjust instantaneously.

$$y_t = \alpha + \beta(1-\lambda)\sum_{i=0}^{\infty}\lambda^i x_{t-i} + \sum_{i=0}^{\infty}\lambda^i \varepsilon_{t-i} \qquad (35)$$

In autoregressive form

$$y_t = \alpha(1-\lambda) + \lambda y_{t-1} + \beta(1-\lambda)x_t + \left(\varepsilon_t - \lambda\varepsilon_{t-1}\right) \qquad (36)$$

More specifically

$$y_t = \alpha(1-\lambda) + \lambda y_{t-1} + \beta(1-\lambda)x_t^j + \beta(1-\lambda)z_t^j + \beta(1-\lambda)H_t + \left(\varepsilon_t - \lambda\varepsilon_{t-1}\right) \qquad (37)$$

Where:

$y_t$ = hospital action;
$x^j_t$ = vector of hospital characteristics indexed by j in time t;
$Z^j_t$ = vector of market characteristics indexed by j in time t;
$H_t$ = Hospital HMO percentage.

The partial adjustment model for HMO penetration in the hospital may be written similarly. To specify the structural relationships between hospitals and HMOs fully, it is necessary to specify the relationship between hospital characteristics, market characteristics and HMO%:

$$H_t = \alpha(1-\lambda) + \lambda H_{t-1} + \beta(1-\lambda)x_t^j + \beta(1-\lambda)z_t^j + \beta(1-\lambda)y_t + \left(\varepsilon_t - \lambda\varepsilon_{t-1}\right) \qquad (38)$$

where:

$y_t$ = hospital action;
$x^j_t$ = vector of hospital characteristics indexed by j in time t;
$Z^j_t$ = vector of market characteristics indexed by j in time t;
$H_t$ = Hospital HMO percentage.

### 4.4.c The Empirical Model

More specifically, the system of 4 equations estimated using 3SLS is as follows:

1) $\text{Action}_t = \alpha_1 + \beta_{11}{*}\text{Action}_{t-1} + \beta_{12}{*}\text{HMO}_{t-1} + \beta_{13}{*}\text{FP}{*}\text{HMO}_{t-1} + \beta_{14}{*}\text{Performance}_{t-1} + \beta_{15}{*}\text{Monitoring}_t + \beta_{16}{*}\text{FP}{*}\text{Monitoring}_t + \beta_{17}{*}\text{FP}_t + \beta_{18}{*}\text{System}_t + \beta_{19}{*}\text{Size}_t + \beta_{110}{*}\text{HHI}_t + \beta_{111}{*}\text{MHShare}_t + \beta_{112}{*}\text{FPShare}_t + \beta_{113}{*}\text{Income}_t + \beta_{114}{*}\text{Education}_t + \varepsilon_{1t}$

2) $\text{HMO}_t = \alpha_2 + \beta_{21}*\text{HMO}_{t-1} + \beta_{22}*\text{Action}_{t-1} + \beta_{23}*\text{FP}*\text{Action}_{t-1} + \beta_{24}*\text{Monitoring}_t + \beta_{25}*\text{FP}*\text{Monitoring}_t + \beta_{26}*\text{System}_t + \beta_{27}*\text{Occrate}_{t-1} + \beta_{28}*\text{HHI}_t + \beta_{29}*\text{MktHMO}_t + \beta_{29}*\text{Medicaid}_t + \beta_{210}*\text{Density}_t + \varepsilon_{2t}$

3) $\text{Monitoring}_t = \alpha_3 + \beta_{31}*\text{Action}_t + \beta_{32}*\text{HMO\%}_t + \beta_{33}*\text{Wage}_t + \beta_{34}*\text{FP}_t + \beta_{35}*\text{Size}_t + \beta_{36}*\text{Ambper}_t + \beta_{37}*\text{Outper}_t + \beta_{38}*\text{Income}_t + \beta_{39}*\text{Medicare}_t + \beta_{310}*\text{Occrate}_t + \beta_{311}*\text{Malprac}_t + \beta_{312}*\text{Manprod}_t + \varepsilon_{3t}$

4) $\text{Performance}_t = \alpha_4 + \beta_{41}*\text{HMO}_t + \beta_{42}*\text{Action}_t + \beta_{43}*\text{Monitoring}_t + \beta_{44}*\text{FP}*\text{Monitoring}_t + \beta_{45}*\text{FP}*\text{Action}_t + \beta_{46}*\text{HMO}*\text{Action}_t + \beta_{47}*\text{FP}_t + \beta_{48}*\text{System}_t + \beta_{49}*\text{Size}_t + \beta_{410}*\text{HHI}_t + \beta_{411}*\text{Medicare}_t + \beta_{412}*\text{Medicaid}_t + \beta_{413}*\text{Expense}_t + \varepsilon_{4t}$

Variables are defined in table 5.1.

A general discussion of each of these equations follows. Table 4.3 presents the study hypotheses for each equation in each of the 11 models and relates them to the general hypotheses found at the end of Chapter 3.

**Discussion of Equation 1 - Hospital Action**

Hospital action is modeled as a function the following study variables: HMO penetration in the hospital in the lagged period, HMO percentage interaction with hospital FP status, the degree of monitoring, and FP status interaction with monitoring.

Hospital action is also a function of hospital and market characteristics. Hospitals may differ with respect to both their perception of the need to adjust their stocks of capacity as well as their ability to do so. Hospitals with high operating margins may be more able to increase resource intensive capacity due to the presence of organizational slack. At the same time, however, the presence of prior good performance may reduce the perceived need for the hospital to change. For-profit hospitals, in their effort to maximize profits, may be more likely to make changes in their organization to increase them. Non-profit hospitals, on the other hand, as demonstrated by the model in the preceding section, value the delivery of inputs as well as the pursuit of profits. This may lead non-profit hospitals to not adjust their stocks of capacity to the degree seen in for-profit hospitals. System hospitals may have greater financial resources than hospitals that are not members of multi-hospital systems. In addition, hospitals that are part of a hospital system may respond differently as the system as a whole attempts to rationalize services across all member hospitals. Hospital size is also an important determinant of hospital action. Larger hospitals may have greater power with respect to their relationship with HMOs and as a result may not be as likely to change their organizations; it may also be more difficult to change a larger hospital to the extent that smaller hospitals are more nimble in a market setting. Finally, a hospital may require operating surpluses to add capacity, or reduced operating margins may necessitate a greater adjustement by the hospital in subsequent periods.

Hospitals may also be responsive to market pressures. Increased competition in the market may increase the need for the hospital to respond by changing it osrganizational characteristics. Similarly, markets in which there is a high for-profit share or high multi-hospital system share may indicate markets in which there is a heightened level of competition. Finally, median income and education may proxy individual demand for care.

## Discussion of Equation 2 – HMO demand

This equation specifies the HMO demand equation in which change in HMO penetration is modeled as a function of hospital action, for-profit interaction with hospital action, monitoring, for-profit interaction with monitoring, hospital characteristics, market characteristics, and market HMO demand.

A supposition of this thesis is that hospitals respond to HMO penetration, and correspondingly these action affect subsequent contracting with HMOs. If HMO penetration does in fact affect the behavior of hospitals, this is due to their presumption that by changing their organization they will enhance the probability they will receive increased HMO demand. The sign of the coefficient depends on the action variable in the system. The interaction term for action with for-profit status allows for the possibility that FP action differentially affects the change in HMO penetration in the hospital.

Hospital characteristics affect HMO contracting. Membership in a multi-hospital system may increase the demand by HMOs, particularly if the HMO is attempting to contract over a region. This may reduce the cost of contracting and therefore increase the probability of contracting with the hospital. A low occupancy rate may indicate the hospital's desire or ability to take on HMO patients; if the hospital has a high occupancy rate, it may be less willing to adjust its organization or to take HMO patients. As a result, a higher occupancy rate may reduce the level of the HMO percentage in the hospital. Finally, the hospital's Medicaid percentage may reflect the demand for the hospital services by a population with preferences differing from those of HMO patients.

Market variables also influence the hospital's HMO percentage. A market in which there is a high level of competition may increase the hospit,al's desire to take on HMO contracts. As a result the coefficient on the market Herfindahl index should be positive. The hospital's HMO share is a function of the overall level of HMO market penetration. Finally, markets in which there is a high population density should have a greater HMO percentage because it is less costly for the HMO to negotiate capitated contracts with hospitals.

### Discussion of Equation 3 – Hospital Monitoring

Hospital monitoring is modeled as a function of hospital action, HMO percentage and a series of controls. The two study variables of interest, hospital action and HMO percentage, are meant to test the extent to which hospital action is a substitute for monitoring and the extent to which HMO percentage drives increased hospital monitoring.

A number of hospital characteristics are also included. The wage for monitoring staff should have a negative effect on the level of monitoring. For-profit status should increase the level of monitoring by proposition 1 in chapter 3. Larger hospitals may need additional monitoring to coordinate delivery of care. Hospitals with a high outpatient and ambulatory service mix may also require less monitoring because of care is being delivered in a low-intensity setting. Hospital malpractice insurance expenses should increase the amount of monitoring in the hospital because the marginal value of monitoring increases in additional malpractice expenses.

### Discussion of Equation 4 – Hospital performance

Hospital performance is modeled as a function of hospital action, monitoring, interaction between for-profit status and monitoring and hospital action, the HMO percentage in the hospital, interaction between action and HMO %, and a series of control variables that may affect performance.

This equation takes the endogenous variables from the prior three equations and estimates the impact on hospital performance. The controls include for-profit status, membership in a multi-hospital system, hospital size, Medicare and Medicaid percentages, as well as the competitiveness of the market. Increasing market concentration should increase the profitability of the hospital.

## *4.5 Hypotheses*

This section operationalizes the general hypotheses put forth in Chapter 3 and argues for the presence of particular relationships across each of the three classes of dependent variables. A summary of the hypotheses may be found in table 4.3.

The theoretical model suggests that the hospital will reduce its level of capacity in response to managed care in an effort to deliver a lower level of inputs (R) in a more cost-effective fashion. Furthermore, the principal-agent model suggests that limiting the availability of resources may be a more costly form of limiting the delivery of inputs than monitoring each physician, because the hospital cannot constrain capital differentially across patient types. At the same time, the model demonstrates that NFP hospitals have an explicit preference for the delivery of inputs to the patient, partially as a function of their objective function and partially as a function of the imperfect agency relationship that exists with physicians. Not-for-profit hospitals have a preference for volume where FP hospitals do not; this sheds light on the hypothesized relationship between HMO penetration and hospital action.

The second equation in the model is concerned with how hospital action and choice of monitoring affects demand in the hospital for HMO patients. Changes in hospital actions and monitoring which lead to the delivery of a lower level of inputs should be associated with an increase in HMO percentage.

The third equation in the model is concerned with the level of monitoring. This is a function of hospital action (a presumed substitute to the extent that action reduces the availability of hospital inputs), HMO%, and proxies for hospital demand.

Finally, the fourth equation examines the relationship between HMO percentage, hospital action, monitoring and financial performance. By their very nature HMOs are assumed to negotiate a larger discount of lower level or reimbursement for the lower level of services they desire for their insured population. As a result, the hypothesized effect of increasing HMO penetration would be to decrease operating margins. The theoretical model suggests that the HMO writes a contract with the hospital such that the hospital breaks even. At the same time hospital action, consistent with HMO objectives, is hypothesized to have a positive effect on operating margin. The true acid test of hospital response to HMO penetration is tested with the interaction term, which captures the additional effect of hospital response attributable to the presence of HMO penetration.

### Specific Discussion of Hypotheses on Study Variables

Each of the 11 actions represents an addition to or reduction of capacity. HMOs are assumed to desire a lower level of capacity and intensity. This underlying dimension of each action is hypothesized to direct hospital action and response in each of the four equations. For this reason, it is useful to present the following relationships:

- An increase in Subacute Care % **reduces** intensity and capacity to deliver intensive services.
- An increase in Acute Care % **increases** intensity and capacity to deliver intensive services.
- An increase in Intensive Care % **increases** intensity and capacity to deliver intensive services.
- An increase in Total Beds **increases** intensity and capacity to deliver intensive services.
- An increase in Total FTEs **increases** intensity and capacity to deliver intensive services.
- An increase in Ambulatory FTEs **decreases** intensity and capacity to deliver intensive services.
- An increase in Purchase of fixed equipment **increases** intensity and capacity to deliver intensive services.
- An increase in Purchase of moveable equipment **increases** intensity and capacity to deliver intensive services.
- An increase in % of capital retired **decreases** intensity and capacity to deliver intensive services.
- An increase in % of capital added **increases** intensity and capacity to deliver intensive services.
- An increase in ratio of capital retired to capital added **decreases** intensity and capacity to deliver intensive services.

Hospital Action - Equation #1

**HMO%:** The effect of HMO percentage on each of the 11 actions is predicated on the assumption that HMOs desire that a lower level of hospital inputs be expended in the treatment of their patients. As a result, the predicted sign of HMO% in each equation corresponds to the effect of the action on the level of services delivered. For example, a hospital which increases its percentage of beds allocated to intensive care settings will be more likely on the margin to deliver more acute care. By the same token, HMO patients due to the selection bias native in HMO plans are likely to demand fewer HMO services. As a result, the coefficient on HMO % in the % Beds Intensive Care System is predicted to be negative. The converse positive coefficient is hypothesized for subacute care %. For similar reasons, the hypothesized effect on Acute Care % beds is hypothesized to be negative. HMO patients are likely to have a lower demand for hospital service in general, and acute care constitutes the largest percentage of such service.

The second class of actions is concerned with the hospital's choice of scale. Hospital HMO% is hypothesized to reduce the number of hospital beds and hospital FTEs while increasing the number of ambulatory staff. This is a natural outgrowth of the HMOs assumed preference for fewer hospital services and more outpatient or ambulatory services. In addition, a hospital that has more beds and employees is more likely to use those inputs to deliver a higher level of care. By reducing the number of beds and staff the hospital may effectively limit the use of its services by physicians.

The third set of 5 systems assesses the effect of HMO% on capital levels and allocations within the hospital. HMO percentage is hypothesized to reduce both fixed and moveable equipment purchases, as well as the percentage of capital added more generally. Conversely, HMO% is hypothesized to increase the retirement of existing capital as well as the ratio of capital disposed to capital added, because the hospital attempts to ration capital in response to HMO % in an effort to reduce inputs delivered. Operationally, this may take the form of a hospital not purchasing a new PET scanner or selling off existing equipment that may be used to increase the intensity of treatment.

**FP*HMO%** For all actions the effect of the interaction term is hypothesized to be opposite in sign from the effect of HMO% alone, because FP hospitals are likely to respond to a lesser degree than NFP hospitals for the reason stated in hypothesis H.A.2.

**Monitoring:** Monitoring is hypothesized to be a substitute for reductions in capacity in response to an increasing HMO percentage. For example, an increase in HMO% may lead to a reduction in ICU% because the hospital has to constrain the availability of these services to deliver a lower level of inputs. Alternatively, this could be achieved by increasing the monitoring of those services which are likely to be associated with an increase in the delivery of hospital inputs. For this reason I hypothesize that monitoring would increase a hospital's ICU %. In short, the coefficient on HMO% represents the direction of the HMO's desired adjustment in hospital capacity. The coefficient on monitoring will be the opposite for scope, scale, and capital investment, all of which are directly related to the hospital's ability to deliver a lower level of hospital inputs.

**FP*Monitoring:** The hypothesized sign in each of the models is the opposite of the sign on monitoring alone because FP hospitals are hypothesized to require less adjustment or change in their level of monitoring than NFP hospitals.

### HMO % Equation #2

**Action:** The effect of HMO % on hospital action is identical to the hypothesized sign of hospital action on HMO%. A hospital that alters its service or capital mix toward a lower level of resource intensity will meet with increased HMO demand.

**FP*Action:** The effect of hospital actions by FP hospitals is likely to be less than for not-for-profit hospitals. This is not to say, however, that it will be the opposite, but rather less in magnitude but of the same direction. This is because FP hospitals are likely to be closer to the desired service mix of the HMO and as a result need to change less than non-profit hospitals.

**Monitoring:** To accept HMO contracts, the hospital, any hospital, must have a control or monitoring mechanism in place to constrain the delivery of inputs. For this reason the hypothesized sign of monitoring is positive for all 11 models, regardless of action.

**FP*Monitoring** Again, the relationship between monitoring and FP status with HMO% is likely to be weaker. For-profit hospitals are presumed to be closer to the desired service mix and have a lower level of slack resources to be monitored. For this reason the coefficient on FP*monitoring will be negative for all 11 models.

### Monitoring Equation #3

**Action:** Actions that increase the level of intensity or the capacity of the hospital will require additional monitoring. Consistent with the argument that monitoring may be a substitute or complement[41] for action, the sign on action in each equation will be the same as the sign of monitoring on hospital action in equation #1.

**HMO%:** Increases in HMO percentage in the hospital increase the level of monitoring by the hospital for the same reason that increases in monitoring increase the HMO% in the hospital. Hence, the coefficient on HMO% is hypothesized to be positive in all models.

### Performance - Equation #4

**Action:** Hospital action or increase along each of the 11 dimensions studied is hypothesized to decrease hospital performance. The logic is simple. The dominant payer share in most hospitals throughout the study period is not the HMO. Assuming that the hospital was configured in an equilibrium service determined by FFS insurers and to the extent that changing the existing service towards that preferred by managed care patients results in lower returns for existing traditionally insured patients, the effect of these actions will have a negative effect on performance.

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[41] If the hospital action increases the intensity of service there should be a corresponding increase in the level of monitoring to ensure that the level of service does not increase. If the hospital increases a lower intensity service however, monitoring will act as a substitute and will have a negative sign.

**Monitoring:** Hospital monitoring is hypothesized to have a positive effect across all models, because while actions that adjust capacity or capital availability must necessarily affect the hospital population overall, the effect of monitoring may be targeted to the HMO population. As a result, the constraining effects of monitoring may be more targeted and will not adversely affect the high level of service provided to the non-HMO patients.

**FP*Monitoring:** The additional effect attributable to for-profit hospitals will have a positive effect on performance.

**FP*Action:** The additional effect of for-profit status action on performance is positive.

**HMO%:** The hospital's HMO% will have a consistently negative effect on its performance. Either through aggressive contract negotiations or the capitated nature of contracts written with hospitals HMO plans are likely to reduce the hospital's operating margins. By design the HMO would like to write a contract that pays the hospital only its long run average cost. If the HMO does write a capitated contract with the hospital, due to its private information regarding expected patient demand it will be in a position to write an advantageous contract.

**HMO%*Action:** This is potentially the true acid test of hospital response to managed care and its subsequent effect on hospital performance. The hypothesized coefficient is positive. The marginal effect of hospital response directly attributable to HMO% will have a positive impact on performance.

**Table 4.1 Mean Hospital HMO % by Market and Time**

| Market | N | 1989 | 1991 | 1994 | Change |
|---|---|---|---|---|---|
| DAYTONA BEACH, FL | 4 | 1.92% | 17.65% | 32.58% | 30.66% |
| FORT LAUDERDALE, FL | 13 | 12.67% | 25.50% | 34.84% | 22.17% |
| FORT MYERS-CAPE CORAL, FL | 2 | 0.00% | 2.58% | 4.57% | 4.57% |
| FORT PIERCE-PORT ST. LUCIE, FL | 2 | 3.19% | 3.68% | 7.28% | 4.09% |
| FORT WALTON BEACH, FL | 3 | 9.48% | 11.39% | 15.96% | 6.48% |
| GAINESVILLE, FL | 2 | 7.16% | 23.49% | 28.17% | 21.01% |
| JACKSONVILLE, FL | 7 | 16.27% | 24.64% | 21.77% | 5.50% |
| LAKELAND-WINTER HAVEN, FL | 5 | 9.40% | 11.29% | 12.68% | 3.28% |
| MELBOURNE-TITUSVILLE-PALM BAY, FL | 3 | 2.79% | 6.63% | 17.48% | 14.68% |
| MIAMI, FL | 17 | 14.43% | 25.13% | 31.46% | 17.03% |
| NAPLES, FL | 1 | 0.00% | 0.00% | 0.01% | 0.01% |
| OCALA, FL | 3 | 0.58% | 3.90% | 9.35% | 8.76% |
| ORLANDO, FL | 9 | 8.80% | 16.56% | 20.56% | 11.76% |
| PANAMA CITY, FL | 1 | 6.08% | 0.00% | 17.27% | 11.19% |
| PENSACOLA, FL | 6 | 12.06% | 13.41% | 16.75% | 4.69% |
| PUNTA GORDA, FL | 2 | 0.00% | 0.00% | 3.84% | 3.84% |
| SARASOTA-BRADENTON, FL | 3 | 0.00% | 4.81% | 10.12% | 10.12% |
| TALLAHASSEE, FL | 3 | 18.40% | 18.61% | 18.81% | 0.40% |
| TAMPA-ST. PETERSBURG-CLEARWATER, FL | 25 | 6.93% | 14.81% | 19.49% | 12.56% |
| WEST PALM BEACH-BOCA RATON, FL | 12 | 8.19% | 20.84% | 30.77% | 22.58% |
|  |  |  |  |  | 10.77% |

**Table 4.2 Std. Deviation of Hospital HMO % by Market and Time**

| Market | N | 1989 | 1991 | 1994 | Change |
|---|---|---|---|---|---|
| DAYTONA BEACH, FL | 4 | 2.97% | 24.42% | 20.60% | 17.63% |
| FORT LAUDERDALE, FL | 13 | 19.10% | 19.63% | 23.77% | 4.66% |
| FORT MYERS-CAPE CORAL, FL | 2 | 0.00% | 2.77% | 2.14% | 2.14% |
| FORT PIERCE-PORT ST. LUCIE, FL | 2 | 1.42% | 0.74% | 2.14% | 0.71% |
| FORT WALTON BEACH, FL | 3 | 8.29% | 4.92% | 8.87% | 0.57% |
| GAINESVILLE, FL | 2 | 10.13% | 0.45% | 1.47% | -8.66% |
| JACKSONVILLE, FL | 7 | 16.82% | 10.65% | 13.86% | -2.96% |
| LAKELAND-WINTER HAVEN, FL | 5 | 12.32% | 11.21% | 5.66% | -6.66% |
| MELBOURNE-TITUSVILLE-PALM BAY, FL | 3 | 3.54% | 6.24% | 7.99% | 4.45% |
| MIAMI, FL | 17 | 12.72% | 12.04% | 11.86% | -0.86% |
| NAPLES, FL | 1 | . | . | . |  |
| OCALA, FL | 3 | 1.01% | 3.31% | 1.36% | 0.35% |
| ORLANDO, FL | 9 | 9.84% | 13.07% | 15.00% | 5.16% |
| PANAMA CITY, FL | 1 | . | . | . |  |
| PENSACOLA, FL | 6 | 8.50% | 6.40% | 6.63% | -1.86% |
| PUNTA GORDA, FL | 2 | 0.00% | 0.00% | 5.42% | 5.42% |
| SARASOTA-BRADENTON, FL | 3 | 0.00% | 3.47% | 3.64% | 3.64% |
| TALLAHASSEE, FL | 3 | 14.03% | 12.47% | 13.20% | -0.83% |
| TAMPA-ST. PETERSBURG-CLEARWATER, FL | 25 | 9.64% | 12.67% | 14.42% | 4.79% |
| WEST PALM BEACH-BOCA RATON, FL | 12 | 11.55% | 14.01% | 15.13% | 3.58% |
|  |  |  |  |  | 1.74% |

## Table 4.3: Hypothesized Signs on Study Variables

| General Hypothesis - Ch. 3 | Equation #1: Hospital Action | % Beds Subacute | % Beds Acute | % Beds Intensive Care | Total Licensed Beds | Total FTEs | Ambulatory Staff FTEs | Purch. Fixed Equiptment | Purch. Moveable Equipt. | % Capital Retired | % Capital Added | Ratio: Reitred / Added |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H.A.1 | HMO % | + | - | - | - | - | + | - | - | + | - | + |
| H.A.2 | FP*HMO% | - | + | + | + | + | - | + | + | - | + | - |
| H.B.1 | Monitoring | - | + | + | + | + | + | + | + | - | + | - |
| H.B.2 | FP*Monitoring | + | - | - | - | - | - | - | - | + | - | + |
| | **HMO % - Eq#2** | | | | | | | | | | | |
| H.C.1 | Action | + | - | - | - | - | + | - | - | + | - | + |
| H.C.2 | FP*Action | - | + | + | + | + | - | + | + | - | + | - |
| H.D.1 | Monitoring | + | + | + | + | + | + | + | + | + | + | + |
| H.D.2 | FP*Monitoring | - | - | - | - | - | - | - | - | - | - | - |
| | **Monitoring - Eq#3** | | | | | | | | | | | |
| H.F | Action | - | + | + | + | + | + | + | + | - | + | - |
| H.E | HMO % | + | + | + | + | + | + | + | + | + | + | + |
| | **Performance - Eq#4** | | | | | | | | | | | |
| H.G.1 | Action | - | - | - | - | - | - | - | - | - | - | - |
| H.H | Monitoring | + | + | + | + | + | + | + | + | + | + | + |
| | FP*Monitoring | + | + | + | + | + | + | + | + | + | + | + |
| | FP * Action | + | + | + | + | + | + | + | + | + | + | + |
| H.I | HMO % | - | - | - | - | - | - | - | - | - | - | - |
| H.G.2 | HMO * Action | + | + | + | + | + | + | + | + | + | + | + |

# Chapter 5: Empirical Results

This chapter discusses the results from the 11 systems of equations estimated on the Florida data. These results from this analysis are presented in tables 5.1 - 5.19.

| | |
|---|---|
| Table 5.1 | Variable Means by Year |
| Table 5.2 | Variable Standard Deviations by Year |
| Table 5.3 | Correlation table for independent variables in equations |
| Table 5.4 | Model Fit and Equation Cross Correlation |
| Table 5.5 | Action Variable % Subacute Beds |
| Table 5.6 | Action Variable % Acute Care Beds |
| Table 5.7 | Action Variable % ICU Beds |
| Table 5.8 | Action Variable Licensed Beds |
| Table 5.9 | Action Variable Total FTEs |
| Table 5.10 | Action Variable Ambulatory FTEs |
| Table 5.11 | Action Variable Purchase of Fixed Equipt. |
| Table 5.12 | Action Variable Purchase of Moveable Equipt |
| Table 5.13 | Action Variable % Capital Retired |
| Table 5.14 | Action Variable % Capital Added |
| Table 5.15 | Action Variable Ratio of Capital Ret. / Added |
| Table 5.16 | Summary of Hypothesized Signs on Study Variables |
| Table 5.17 | Summary of Results on Study Variables |
| Table 5.18 | Summary of Confirmation / Rejection of Study Hypotheses |
| Table 5.19 | Summary of Control Variables |

The discussion of the results will proceed as follows:

- Discussion of summary statistics from Tables 5.1 - 5.2
- Discussion of correlation among independent variables from Table 5.4
- Discussion of Model fit and cross Correlation from Table 5.5
- Discussion of model results on study variables from Tables 5.6 - 5.16
- Discussion of control variables
- Summary of support for general hypothesized results.

### *Discussion of Summary Statistics*

Table 5.1 presents the means for variables used in the systems of equations for each of the 6 years as well as the percentage growth from 1989 to 1994. Changes in the mean levels of these variables present some interesting results in their own right with respect to how hospital services, characteristics and markets are changing over time.

## Capacity

First, there has been very modest growth (4.24%) in hospital bed capacity over the period. Acute care beds, which account for the largest percentage of hospital capacity, have decreased over time by 4%. At the same time, the percentage of hospital beds allocated to a subacute care setting, while modest (approximately 2%), has increased 113%. There has been a more modest growth of 10% in intensive care beds. This is consistent with a general trend in hospitals toward a bimodal distribution of patients with both higher and lower patient acuity. It may be the case that patients who require intensive care services have a largely inelastic demand for care and as a result managed care may have a modest effect on the hospital's ability to reduce these services.

Hospitals are also increasing the size of their staff. There is a 21% increase in the total hospital staff over the study period. At the same time, however, the growth in outpatient staff has increased 51% overall and 24% as a percentage of total hospital FTEs. The percentage of hospital staff allocated to monitoring functions (medical care review and medical staff administration) has increased 13%. This suggests that in aggregate hospitals have been growing rather significantly, and an increasing percentage of hospital's growth is occuring outside of the traditional inpatient setting. Finally, the growth in monitoring staff, while increasing, has not kept pace with the growth in staff overall. Coupled with the reduction in the percentage of employees in direct patient care from 51% to 48%, this suggests that administrative overhead is increasing over time.

## Capital

The other way in which hospitals may limit the delivery of hospital inputs is through reductions in available capital. On average hospitals increased the percentage of capital retired only modestly, approximately 5%. At the same time, however, hospitals were more likely to add additional capital to their organizations. The growth rate in new capital as a percentage of total capital increased approximately 42%; some of this was in the purchase of new equipment. While the change in fixed equipment was negligible (around 1%), there was a 17% increase in the percentage of capital allocated to moveable equipment. It is interesting to note the variability over time in the ratio of capital disposed to capital added. This variable is an attempt to condense the additions and deletions from capital into one measure. Values greater than 1 indicate the hospital is retiring capital, while values less than 1 indicate that the hospital is in aggregate adding capital. In 5 of the 6 years on average hospitals increased their level of capital.

## Population statistics as they relate to increasing managed care penetration

The hypotheses tested in this thesis suggest that increases in managed care penetration will result in increases in monitoring as well as reductions in resource-intensive capacity. Some of the population level changes suggest that this is not supported in the data. In particular, there are increases in intensive care percentage, total hospital beds, total hospital employees, percentage of new capital added, and the purchase of fixed and moveable equipment. These population level trends would appear contrary to the hypotheses. On the other hand, uncovering an effect of managed care which is contrary to what is seen at the population level makes the results more interesting. The reason that there may be increases at the population level while the effect of HMO on these variables is negative in the ensuing models may be attributable to two effects. First, there may be a series of confounding relationships or covariates which when combined with the effect of managed care may mute or cancel out any hypothesized effect. Second, it is possible that while the trend in these variables is consistently positive, managed care dampens the rate of growth. This suggests the importance of the multivariate analyses which are performed in this chapter.

To demonstrate the underlying variability in some of these dependent study variables, a secondary analysis of the summary statistics was performed. For each of the dependent variables in the analysis, a difference was estimated between 1989 and 1994. This created a variable representing the change over time. A similar variable was constructed for the hospital's managed care percentage. Then, based on the 5-year change in managed care penetration in the hospital, two groups were created: those hospitals in the lowest quartile of the distribution and those in the highest quartile. This effectively identified those hospitals in which there was little change in HMO percentage and those hospitals with the greatest growth rates. In the extreme, this controls for the possibility that hospitals which had very little managed care were driving the growth in some of the dependent study variables previously mentioned and masking reductions by hospitals with a large increase in managed care. Finally these samples were again partitioned based on the for-profit, not-for-profit status of the hospital. Means were then calculated for the change in the dependent variables within the low change and high change HMO percentage quartiles. This partially controlled for the effects of ownership and HMO percentage on each of the study variables. These results are presented in tables 5.2a and 5.2b.

This relatively simple characterization demonstrates the importance of managed care. At the population level of 123 hospitals, the intensive care percentage (INTNPER) increased from 8.5% to 9.4% or 10.28% over the study period. Not all subsets of hospitals, however, experienced a 10.28% increase. With respect to not-for-profit hospitals, those in the bottom quartile of HMO growth actually reduced their ICU%, while the hospitals in the top quartile increased their ICU% by 1.6%. These results are reversed for for-profit hospitals. In for-profit hospitals, those in the bottom quartile of growth increased their ICU% by .82%, while hospitals in the top quartile reduced their ICU% by .08%. While the reduction is small, compared with the increase by the bottom-quartile hospitals the difference is approximately 1%. This illustrates the importance of the covariates in the analysis.

The importance of the change in HMO percentage is clearly evident in the other study variables as well. While total hospital beds increased in the population at large, the rate of growth for not-for-profit hospitals in the high change quartile was much less than for the NFP hospitals in the low change quartile. The same result is found with respect to growth in total hospital employees. Additional explanatory variables such as the hospital's financial performance will obviously affect these results further. The presence of the underlying variability in the effect of managed care on the capacity and capital structure variables lends support for the hypotheses tested in the ensuing section.

### Selected Market / Hospital Characteristics

This thesis is primarily concerned with the effect of increasing HMO penetration on hospital action. Hospital HMO% increased almost 150% during the six-year period. The market also appears to be becoming more concentrated, with a 9% increase in the market HHI. Interestingly, there is a 61% growth in the Medicaid percentage and a 21% increase in the amount of charity care delivered.

### Variation in the Sample over Time

Examination of the mean values of each of the variables masks the potential underlying variation which may drive results. Table 5.2 presents the standard deviations of each of the variables over the six-year study period. The column titled "Change" is the percentage change in the standard deviation from 1989 to 1994. Large reductions or increases in the standard deviation suggest that over time there is either more or less dispersion in each of the independent variables in the sample. The final column in the table is the mean standard deviation across the six years.

### Capacity

The change in the standard deviation for the percentage of hospital beds allocated to acute and intensive care is modest though increasing over time. The standard deviation for percent of hospital beds allocated to sub-acute care, however, grows by more than 43%. This suggests that hospitals are increasing their sub-acute care percentage at varying rates. There has been a modest increase (between 20% and 40%) in variation about the population mean in full-time employees and ambulatory staff FTEs.

Looking across the table for the capital adjustment variables, it is evident that there does not exist a persistent time trend. The standard deviations tend to vary significantly from year to year. This is consistent with the observation that in these models the lagged dependent variable was not significant. There is little change in the variability of the purchase of new equipment over time, but there does appear to be a reduction in the variation about the mean level of moveable equipment purchase.

### Selected Market / Hospital Characteristics

HMO penetration in hospitals appears to become increasingly varied over time. The mean hospital HMO percentage increases (as seen in Table 5.1) from 9% to 22%, with a corresponding standard deviation of 12% to 16% (a 32% increase). Clearly some hospitals are experiencing growth rates in HMO percentage while others are not, leading to an increase in the dispersion of the mean hospital HMO percentage. Interestingly the growth of dispersion in for-profit hospitals with respect to HMO percentage (79%) is greater than for non-profit hospitals. Most of the other independent variables, including market HHI, remain reasonably constant with respect to change in their standard deviations over time, suggesting that these variables may be affecting hospitals in a uniform fashion.

### *Correlation Table Discussion*

Table 5.4 presents the partial correlation of each independent variable with all other independent variables in the equation system. It is evident from this table that the vast majority of the variables are not highly correlated. Variables which tend to be more highly correlated are the interaction terms between for-profit status and HMO % and for-profit status and monitoring. As a result, there does not appear to be a problem with multi-collinearity in the system of equations estimated.

### *Model Fit*

Table 5.5 presents the system weighted R-squared[42]. Since in each system of equations two partial adjustment models are estimated for hospital action and HMO percentage, the system weighted $R^2$ reflects the fit of these models. In general the models fit the data well, with system weighted $R^2$ ranging from a low of .596 for the purchase of fixed equipment equation to a high of .952 for the number of total licensed hospital beds. Again, any one of the four equations in the system may not fit the data as well as is suggested by the system weighted $R^2$.

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[42] When instrumental variables are used the regression sum of squares (RSS) and the error sum of squares (ESS) do not sum to the total corrected sum of squares. As a result the measure of $R^2$ employed here is equal to RSS / (RSS + ESS).

Table 5.5 also presents the cross-model correlation between the hospital action equation (equation #1) and the hospital monitoring equation (equation #3). This value is the correlation between the error terms of the two equations in question. Of particular interest in this empirical inquiry is the extent to which monitoring is a substitute for hospital action. As a result, monitoring is found in the hospital action equation and hospital action is entered in the monitoring equation. These variables directly test the non-random relationship between monitoring and action. The remaining error term and the corresponding correlation of the error terms between these two equations captures the non- systematic component and its relationship between equations. Simply stated, after controlling for all the factors that affect hospital action and monitoring, the residuals may still be correlated due to omitted variables. In particular, monitoring or hospital action not specifically measured in the equations may still drive the relationship between the two equations. If monitoring and action are indeed substitutes for one another, one would expect to see a negative coefficient on the cross-model error term correlation. In 8 of the 11 models the correlation is negative, suggesting that as the residuals or unmeasured effects of action move in one direction the unmeasured effects of monitoring move in the opposite direction. While inconclusive in and of itself, it does lend support for the supposition that hospital action and monitoring may move in opposite directions.

The following sections will address each model of hospital action in sequence. The control variables in the equations will be discussed across all models at the conclusion.

*Discussion of Model Results*

Table 5.18 condenses the 11 pages of model results corresponding to each of the estimated systems into a single table. Each cell entry contains a "Y" if the hypothesis was supported and an "N" if the hypothesis was not supported. If the result was significant, the cell is also shaded. The columns represent the action variable in the system, and the rows indicate the study variable in each of the 4 equations. The final 3 columns summarize the significant results across equations. Significant results supported are the number of hypothesized results which were significant and in the direction hypothesized. Significant results not supported is the number of results in each row which were significant but not in the hypothesized direction. Finally, "% Significant hypotheses supported" is the percentage of significant results which were in the direction hypothesized.

This table is useful for considering each model separately by looking down the column as well as for comparing the robustness of the result across models (columns). I will first discuss each model separately and then discuss the consistency of the relationship across models.

Figures 5.2 through 5.12 are diagrammatic representations of the significant results in each system of equations. The arrows indicate the direction of the effect between the variables which appear in each of the models; these figures correspond to the diagrammatic representation of the full system of equations presented at the end of Chapter 3 but here only significant results are shown. Next to each arrow is the significant coefficient (labeled β), as well as the elasticity for each significant study variable in the system. The elasticity has the benefit of being normalized for the difference in units between the dependent and independent variables so that the effect is expressed as a percentage. From these figures it is easy to see not only the results in the system, but also the magnitude of the effects each construct has on the other.

### Discussion of Hospital Sub-acute Bed % (Table 5.6 / Figure 5.1)

None of the study variables are statistically significant in the hospital action equation. Hospital action and hospital monitoring are significant in the HMO% equation though only the monitoring hypothesis is supported. These results suggest that an increase in hospital subacute care percentage decreases HMO% while an increase in monitoring increases hospital HMO%. Neither study variable is significant in the monitoring equation. Finally, hospital action, monitoring, for-profit action and HMO%*Action are all significant and in the hypothesized direction in predicting hospital performance. Hospital action reduces hospital performance as expected, while increases in monitoring, for-profit action and HMO% interacted with hospital action are all positive as hypothesized. The combined effect of for-profit action with the main effect of action still yields a negative overall impact on hospital performance.

The effect of hospital action in for-profit hospitals is not as adverse as in not-for profit hospitals.

Figure 5.1 graphically represents these results for the non-profit hospital. Since there are no significant results affecting either hospital action or monitoring, this system does not exhibit feedback. A one unit increase in monitoring increases performance by 2.31% and the hospital's HMO percentage by approximately 1%. The hospital's increase in sub-acute care beds has a very small effect on hospital HMO% but yields approximately a 1% reduction in hospital performance.

### Discussion of Hospital Acute Care Bed % (Table 5.7 / Figure 5.2)

No study variable significantly affects hospital action. While HMO% and monitoring do not appear to affect hospital action, action and monitoring do appear to affect HMO%. Although the main effect of hospital action is not significant, the interaction term is positive and significant. This suggests that while action does not affect HMO demand along this dimension in NFP hospitals, FP hospitals that increase the % of beds allocated to acute care will be rewarded with increased HMO demand. Monitoring also has a significant positive impact on HMO% as hypothesized. The interaction term with for-profit status is negative and significant, though the joint effect of the main effect and interaction term is still positive. This suggests that monitoring in NFP hospitals has significantly positive impact on hospital HMO% and is significantly positive but to a lesser degree in FP hospitals. This is as hypothesized, since NFP hospitals have a greater need to control the oversupply of hospital inputs built into their organization.

Both hospital action and HMO% have statistically significant and hypothesized effects on the level of monitoring. Increases in acute care percentage in the hospital reduce the level of monitoring consistent with a substitution of capital reduction for monitoring. Increasing HMO% increases the level of monitoring in the hospital as expected.

Finally, hospital action and monitoring as well as their interaction terms with FP status appear to influence the hospital's operating margin. Hospitals that increase the % of beds allocated to acute care have reduced operating margins as expected. To the extent that this is a substitution away from intensive care services, their returns from FFS patients may be diminished. Monitoring has a negative and significant coefficient, contrary to the hypothesis. This may be because the hospital has over-invested in monitoring given its HMO%. The interaction term between for-profit status and action and monitoring is significant and in the hypothesized direction; that is, the magnitude of the effect of a for-profit hospital's actions and monitoring on operating margin are less than that of a NFP, though in the same direction.

Examination of Figure 5.2 shows the presence of self-reinforcing relationships. Monitoring and HMO % have positive effects on one another, though the effect of monitoring on HMO growth is stronger (elasticities of .93 and .19 respectively).

Reductions in acute care meet with a tremendous increase in performance (a 1% reduction in acute care % leads to a 21% increase in operating margins).

### Discussion of Hospital Intensive Care Bed %, (Table 5.8 / Figure 5.3)

Hospital monitoring and the interaction term between for-profit status and monitoring influence the percentage of the hospital's bed capacity allocated to intensive care in the hypothesized direction. An increase in ICU% increases the intensity of service or availability of hospital resources this must be met with a corresponding increase in the level of monitoring. An increased level of monitoring allows the hospital to increase the ICU% by providing oversight as hypothesized. The interaction term with FP status reduces the magnitude of the monitoring effect.

All study variables are significant and in the hypothesized direction for HMO percentage. A decrease in ICU% increases HMO percentage. An increase in monitoring likewise increases HMO%. The interaction terms with FP status are opposite in sign and therefore reduce the magnitude of action and monitoring in FP hospitals. In fact the interaction term for FP action becomes positive suggesting that for FP hospitals an increase in ICU% leads to an increase in HMO percentage. This may be due to an unmeasured dimension of quality.

Hospital action also increases the level of monitoring in the hospital as hypothesized. If the hospital increases its ICU% (a resource intensive service) this meets with an increase in the level of monitoring in the hospital. While the effect of HMO% on monitoring is positive as hypothesized, it is not significant.

Finally, the results for the effect of action and monitoring for NFP and FP hospitals on performance are all significant but in the opposite direction. This is the one model out of the eleven in which the study variables in the performance equation do not behave as anticipated. In addition as may be seen from Figure 5.3 the elasticities for these study variables are large in magnitude.

Figure 5.3 shows the magnitude of the significant results in the system. Variables that affect performance have particularly large elasticities. A 1% increase in ICU% increases hospital performance by almost 9%, while a 1% increase in the level of monitoring translates into a 3% reduction in performance.

### Discussion of Total Beds (Table 5.9 / Figure 5.4)

None of the study variables significantly affect hospital action. For-profit hospital increases in bed capacity, and increases in monitoring increase HMO% as hypothesized. The positive coefficient on FP hospital action is anomalous, however, given the positive insignificant sign on the main effect of hospital action. The presence of monitoring again increases the probability that the hospital will be able to accept HMO contracts, resulting in higher HMO%.

Neither hospital action nor HMO% significantly influence the level of monitoring. Finally, for-profit hospital increase in hospital beds, HMO% and the interaction term between hospital action and HMO% all significantly influence the level of the operating margin in the hypothesized direction. The positive FP interaction term coupled with the insignificant negative coefficient on the main effect of hospital action reduces the magnitude of the effect. Hospital HMO% has a significant negative effect on hospital operating margin and finally, the joint effect of hospital response to managed care firms specifically increase hospital operating margins.

While the elasticity of HMO% and performance is negative at 1.3, the positive elasticity on the interaction between hospital action and HMO percentage comes close to canceling out the effect. Consistent with the other models, an increase in monitoring results in a .2% increase in HMO%.

### Discussion of Total FTEs (Table 5.10 / Figure 5.5)

Increasing HMO penetration reduces the number of hospital FTEs as hypothesized. This may effectively reduce the level of resources the hospital may credibly deliver to patients. In addition, the operating margin increases the number of FTEs. The only significant study variable affecting HMO% is the change in FTEs; this action works opposite the direction of the hypothesis. A decrease in the number of FTEs reduces HMO%. This may be because the hospital cannot take on HMO patients with reductions in hospital staff.

For-profit hospital increase in hospital FTEs, HMO% and the interaction term between hospital action and HMO% all significantly influence the level of the operating margin in the hypothesized direction. The positive FP interaction term coupled with the insignificant negative coefficient on the main effect of hospital action reduces the magnitude of the effect. HMO% has a significant negative effect on the operating margin, and finally, the joint effect of hospital response to managed care firms specifically increases operating margins.

Of particular note in Figure 5.5 is the reciprocal relationship between hospital action and HMO%. A 1% increase in the number of FTEs results in a 7.6% increase in HMO% while a 1% increase in HMO% leads to a .01% reduction in hospital FTEs. While the partial effect of HMO percentage on performance is negative, the positive coefficient on hospital action significantly reduces the negative impact of HMO percentage in the presence of hospital action.

### Discussion of Ambulatory Staff FTEs (Table 5.11 / Figure 5.6)

Monitoring (the only study variable to affect the change in ambulatory staff significantly) does have a significant positive effect on ambulatory FTEs; this suggests that as the level of monitoring increases the hospital is better able to add ambulatory staff. This confirms the hypothesis that when more resources are available in the presence of agency problems there must be a corresponding increase in the level of monitoring. The effect of monitoring on the HMO% is again positive and significant as hypothesized. The effect of hospital action on the level of monitoring is positive and significant as hypothesized. An increase in the availability of a resource, even in an outpatient setting, requires a greater level of monitoring.

An increase in the number of ambulatory staff FTEs reduces hospital performance. This is consistent with the hypothesis, because, as a hospital reallocates resources to the outpatient setting consistent with the demands of the HMO payer, it is less able to deliver the type of service the other payers wish to obtain. For-profit hospital increase in hospital ambulatory FTEs, HMO% and the interaction term between hospital action and HMO% all significantly influence the level of the operating margin in the hypothesized direction. The positive FP interaction term coupled with the significant negative coefficient on the main effect of hospital action reduces the magnitude of the effect. HMO% has a significant negative effect on hospital operating margin and the joint effect of hospital response to managed care firms specifically increases the operating margins.

Figure 5.7 shows that an increase of 1% in hospital ambulatory FTEs translates into a 2.3% reduction in performance. Here again a 1% increase in hospital HMO percentage leads to approximately 1% reduction in performance. This magnitude of the elasticity is reasonably constant across all the models estimated. The interaction term between hospital action and HMO% is positive and reduces the negative effect of HMO% on hospital performance.

### Discussion of Purchase of Fixed Equipment (Table 5.12 / Figure 5.7)

HMO%, the interaction term between HMO% with FP status, operating margin and the level of monitoring all significantly influence the level of new equipment purchase. A 1% increase in HMO% decreases the change in new fixed equipment by .27; this is consistent with the HMO desiring a lower level of inputs. The interaction term with FP hospital status is positive and significant as hypothesized. When coupled with the main effect of hospital action the effect of FP status is still negative but less in magnitude than for non-profit hospitals. This is consistent with the hypothesis that FP hospitals will need to respond less to managed care organizations due to less of an agency problem. The purchase of more equipment, which makes more resources available must be met with a higher level of monitoring to constrain its use. This is supported with the positive significant coefficient on monitoring.

A hospital that reduces its level of new equipment will increase HMO percentage. In addition, the coefficient on the FP dummy variable is positive, suggesting that adjustment of equipment is less important to the FP hospital in securing HMO contracts. Finally, monitoring is again positive and significant.

An increase in the level of equipment available has a positive and significant effect on the level of monitoring in the hospital: more equipment, more monitoring. Hospitals that increase their level of fixed equipment suffer reduced operating margins. Assuming that hospitals were in equilibrium with respect to their levels of capital and labor before the introduction of managed care, any change in the hospital configuration is likely to be suboptimal for the existing hospital clientele. The effect of reductions in equipment levels is blunted for FP hospitals due to the positive coefficient on the interaction term between for-profit status and hospital action. Monitoring has the hypothesized significant and positive effect on hospital operating margins as well. Finally, the HMO specific impact of hospital action (reduction in hospital purchase of fixed equipment) has a positive and significant impact on hospital performance. Hospitals that respond to increasing managed care penetration by reducing the purchase of new fixed equipment will be rewarded by their HMO business but punished by their existing clientele.

Figure 5.7 graphically shows the reciprocal negative relationship between hospital action and HMO%. An increase in the purchase of fixed equipment reduces HMO%, and a reduction in HMO percentage increases hospital action. In addition, a 1% reduction in the purchase of fixed equipment leads to a 2.7% increase in performance.

### Discussion of Purchase of Moveable Equipment (Table 5.13 / Figure 5.8)

The results on the purchase of moveable equipment are not as strong as on fixed equipment. This may be because moveable equipment is not as resource intensive and as a result does not confer as much of an advantage on the organization through the control of resources. That said, an increase in HMO% in the hospital does translate into a reduction in the percentage of new moveable equipment purchased. This is consistent with the hypothesis.

A hospital that reduces its level of new equipment will increase HMO percentage. In addition, the coefficient on the FP dummy variable is positive suggesting that adjustment of equipment is less important to the FP hospital in securing HMO contracts. Finally, monitoring is again positive and significant. Neither hospital action nor HMO% significantly influence the level of hospital monitoring.

In the hospital performance equation, similar to that for the purchase of fixed equipment, the coefficient is negative suggesting that an increase in moveable equipment reduces hospital operating margins. The interaction term with HMO% is significant and positive as well, swamping out the main effect. Increases in moveable equipment actually increase hospital performance specific to HMO clients. This may be due to the fact that hospitals are too labor intensive and the efficient method for reducing the intensity of service requires a substitution of some capital or equipment for labor. The coefficient on for-profit and hospital action is positive though less in magnitude than the negative main effect of action on hospital operating margin. This suggests that for FP hospitals the effect of a reduction in the level of equipment will be increased operating margins though not as great in magnitude as NFP hospitals.

Figure 5.8 shows the similar negative reciprocal relationship between hospital action and hospital HMO% found in the prior model. Again, a 1% reduction in moveable equipment leads to a 5.7% increase in hospital performance.

### Discussion of Percent Capital Retired (Table 5.14 / Figure 5.9)

The significant coefficient on hospital monitoring on the percentage of hospital capital retired is positive and significant which does not support the hypothesis that monitoring is a substitute for capacity reduction. This result suggests that as the level of monitoring increases the amount of capital retired increases as well. This supports a complementary role between capacity reductions and monitoring.

Increasing the percentage of capital retired is hypothesized to increase the HMO% in the hospital. This is not supported. The presence of monitoring again significantly influence the HMO% in the hospital. Given the contrary results on the effect of monitoring on the percentage of capital reduced, it is not surprising that the coefficient on % Capital Retired in the monitoring equation is again of the incorrect sign. This suggests that as the percentage of capital retired increases, the hospital will increase their level of monitoring.

The effect of the hospital action and monitoring on hospital performance is as expected. An increase in the % of capital retired reduces hospital performance. This is due to the fact that FFS patients value the presence of this capital in the hospital and by reducing the level of capacity the hospital on the margin is not able to deliver as high a level of inputs as is demanded by this portion of the hospital's demand. The effect of monitoring is positive and significant with an elasticity of 2.647.

### Discussion of Percent Capital Added (Table 5.15 / Figure 5.10)

The percent capital added is an alternative attempt to capture the same argument made in % capital retired. As such the hypothesized signs on the study variables is the opposite of the preceding model. In general, this system of equations provides stronger support for the hypotheses put forth in this thesis. Increases in HMO% in the hospital reduce the percentage of capital added as hypothesized. In addition the interaction term is significant and positive for the FP dummy variable suggesting that the effect of HMO% is different, namely less, in FP hospitals on the change in capital added.

Hospital action also influences the HMO% in the hospital. Hospitals which reduce the percentage of capital added are rewarded with increases in HMO% as hypothesized. The coefficient on the FP interaction term is positive therefore reducing the effect of hospital action on HMO% for FP hospitals. Hospital monitoring increases HMO% as in most of the other models. Neither hospital action nor HMO% significantly affects the level of hospital monitoring.

Hospital change in capital added, the interaction term between FP status and hospital action, hospital HMO% and the component of hospital action specific to the HMO% all significantly influence hospital performance. Increasing the percentage of capital added reduces hospital performance. The interaction term for FP hospital action is positive and less in magnitude than the main effect thereby reducing the impact of action in FP hospitals on hospital performance. Hospital HMO% has a significant and negative effect on hospital operating margins. Finally, the interaction term between HMO% and action is positive and significant. In fact it is greater in magnitude than the main effect suggesting that increasing the percentage of hospital capital added increases the returns to HMO patients.

Figure 5.10 shows a negative reciprocal relationship between hospital action and HMO %. In addition a decrease of 1% in the amount of capital added leads to a

4.7% increase in operating margin. HMO% has a negative effect with a 1% increase in hospital HMO% translating to a .7% reduction in hospital operating margin.

### Discussion of Ratio of Capital Disposed to Added (Table 5.16 / Figure 5.11)

None of the study variables appear to significantly influence the ratio of capital disposed to capital added. Further increases in the amount of capital added to capital retired (resulting in a net increase in capital acquired) has a negative impact on HMO%. This is contrary to the hypothesized direction. Monitoring has the same consistently positive effect on hospital HMO%.

Finally, hospital action has the hypothesized negative impact on hospital performance in general though the hypothesized positive effect on performance attributable to action in the presence of HMO%. The size of the elasticities are all small. A 1% increase in the ratio of capital retired to capital added decreases hospital performance by approximately 1%.

### *Discussion of Control Variables:*

Some interesting and persistent results were found on the study variables employed in this analysis. This discussion will be confined to those variables which were consistent and significant across the models estimated. Table 5.19 condenses the signs from the 11 models into a single table.

**Equation #1:** Interestingly enough, very few of the control variables were significant in two-tailed tests. This suggests that hospital size, competition, and factors influencing hospital demand have little effect on hospital action. This is interesting in its own right.

**Equation #2:** The market HMO penetration and hospital Medicaid % were significant across all models. The market HMO penetration had a significant positive effect on the hospital's HMO percentage. This is as expected. The hospital's Medicaid % had a similarly consistent negative effect on the hospital's HMO percentage. This is in part a function of the fact that they are inversely related. As the Medicaid % increases holding everything else (all other payer shares) constant, the hospital's HMO % must fall. The signs on the other control variables in this equation are consistent in sign across models though are not significant.

**Equation #3:** The effect of the hospital being for-profit, having greater than 300 beds, having high malpractice insurance expenses, and admissions per FTE all have a significantly positive effect on the level of hospital monitoring. These signs make intuitive sense. For profit hospitals due to their profit motive have a greater incentive to monitor their production process in an effort to deliver a more cost effective mix of hospital inputs. Larger hospitals by their very nature have more resources available to care for patients. Further as hospitals grow larger their production processes become increasingly complex requiring greater monitoring to ensure efficient production. Malpractice insurance expenses are a measure of the organizations' need to monitor more agressively. Malpractice insurance expenses are related to the level of adverse occurrences in the hospital. As adverse events increase, as reflected in increased expenditures for malpractice insurance, the hospital will engage in more monitoring to reduce these costs. In short, the marginal benefit from an additional unit of monitoring will increase. Finally as the number of admissions per FTE increases the hospital will have to increase the level of monitoring since each admission will receive less oversight by patient care employees. Monitoring in this case will ensure that patients receive treatment in a timely fashion as well as being discharged at the appropriate time.

**Equation #4:** The effect of most of the control variables is contingent on the model being estimated. In each model the action taken by the hospital changes and as a result the marginal impact of the hospital controls change as well. It is interesting to note that membership in a for-profit hospital system has a consistently positive effect on hospital performance as measured by hospital operating margins. This could be attributable to either market power on the part of the system in terms of reducing the level of discounts awarded to managed care plans or possibly an enhanced ability to coordinate services in such a way that care is delivered at a lower cost. There is some support for the observation that larger hospitals have higher operating margins. This could be a natural outgrowth of the economies of scale that result from production in a larger facility. The Market HHI has a similarly positive sign in all models which is significant in 6 of the 11 systems. This states that as concentration in the market (i.e. hospital monopoly power) increases their operating margins increase. This is as expected. An interesting result is that the hospital's Medicare % is positive and significant in 6 of the 11 models. The effect is non-trivial in magnitude as well. For the system with Purchase of Fixed Equipment as the action variable, a 1% increase in hospital Medicare % leads to a 16.5% increase in hospital operating margins. This increases to a 72% increase in hospital operating margins for a 1% increase in the percentage of hospital beds which are allocated to subacute care. Finally, the hospital's expense per bed has a positive effect in all models and a significant effect in 5 of the 11 models. This may be measuring a dimension of quality for which the hospital is being rewarded. It is also possible to the extent that a significant percentage of the hospital's patients have some FFS reimbursement that higher expenses per bed are associated with higher reimbursement which more than covers the additional costs incurred.

Dranove et al. (1993) discuss the impact of the changing nature of purchasers in hospital markets from patients to well informed insurers. They hypothesize that this will 1) reduce hospital profit margins and 2) increase the degree to which the relationship between competition and margins conforms to I/O economic paradigms. Their analysis on California hospital behavior from 1983-1988 find that as payer competition became more keen, the effect of market structure, namely the HHI conforms to traditional I/O postulates. Increases in concentration lead to increases in margins. The results in this section lend further support for their argument regarding the effect of payer driven competition. The consistent positive coefficient on the HHI suggests that markets which were more concentrated increased hospital margins. At the same time higher levels of HMO penetration decreased hospital operating margins.

*Summary of findings across models in relation to hypotheses*

Table 5.18 summarizes the results from the eleven models. This section discusses the robustness of the significant findings for each of the study variables and the extent to which it supports the hypotheses. Support for the hypotheses will be discussed in reference to the general hypotheses from Chapter 3.

> H.A.1) Increases in HMO penetration reduces the level of resource intensive hospital services.

This hypothesis is supported in 4 of the 11 models. All significant results are in the hypothesized direction. Increases in HMO percentage: 1) reduce the number of FTEs, 2) reduce expenditures on fixed equipment, 3) reduce expenditures on moveable equipment and 4) reduce the percentage of new capital added. There are no significant findings contrary to this hypothesis. As a result this hypothesis is supported by a preponderance of the evidence.

> H.A.2) For profit hospitals respond less to HMO penetration than NFP hospitals.

The interaction term between HMO% and FP status is significant and positive in 2 of the 11 models. All significant results are in the hypothesized direction. For-profit hospitals 1) reduce their purchase of fixed equipment and 2) reduce their % of capital added less than non-profit hospitals. There are no significant findings which are contrary to the hypothesis. As a result there is weak support for this hypothesis.

**H.B.1)** Increases in hospital monitoring increases hospital supply of resource intensive services. (Complementary hypothesis)

**H.B.1.A)** Increases in hospital monitoring decreases hospital supply of resource intensive services (Substitution hypothesis)

The complementary hypothesis is supported in 3 of the 4 significant results. Increases in monitoring increase 1) % beds allocated to the ICU, 2) the number of ambulatory staff FTEs and 3) the purchase of fixed equipment. In these models the presence of monitoring affords the hospital the ability, on the margin, to increase the level of these resource intensive services while constraining their appropriate use. The contrary result for the % Capital retired model supports the substitution hypothesis.

**H.B.2)** For profit hospitals will adjust their level of monitoring less than NFP hospitals.

This hypothesis is supported in only 1 of the 11 models. It is however the only model with a significant result. The effect of monitoring in FP hospitals has less impact on the ICU% than in NFP hospitals.

**H.C.1)** Hospital reductions in resource intensive services, and shifts to less resource intensive services increase the hospital's HMO percentage.

The effect of hospital action on HMO% is significant in 8 models. In 4 of these models the result is in the hypothesized direction while in 4 models it is contrary to the hypothesis. As a result this hypothesis in not generally supported by data.

**H.C.2)** For profit hospital action will have less of an impact on HMO demand than will not-for profit action.

This hypothesis is supported in 6 of the 11 models and 6 of the 7 significant results. As a result this hypothesis is generally supported, FP hospital action affects HMO% less than NFP action. Given the fact however that the support for NFP action affecting HMO contracting the support for this hypothesis is suspect. It may be inferred however that NFP action does not have a consistent impact on HMO% while FP action does have a consistent effect on HMO%.

H.D.1) Increases in hospital monitoring increase hospital HMO percentage.

This hypothesis is strongly supported. In 10 of the 11 models hospital monitoring is significant and in all cases the hypothesis is supported.

H.D.2) The response of HMO demand to monitoring is less for FP hospitals than for NFP hospitals.

The effect of FP monitoring on HMO% is significant in 2 of the 11 models. In these two models however the hypothesis is supported. In total however the evidence is equivocal.

H.E) Increases in a hospital's HMO percentage increases hospital monitoring.

While the sign of HMO% on hospital monitoring is positive as hypothesized in all models, the effect is significant in only 1 of the 11 models. As a result, this hypothesis is only weakly supported.

H.F) Reductions in hospital levels of assets which are resource intensive reduces the level of hospital monitoring.

The effect of hospital action on the level of monitoring is significant in 6 of the 11 models. In addition, the hypothesis is supported in 5 of these 6 significant results. As a result, this hypothesis is generally supported.

H.G.1) Hospital action (adjustment of hospital capacity) will reduce performance for traditional patients.

Nine of the eleven models exhibit a significant coefficient on hospital action in the performance equation. In 8 of the 9 cases, this sign is negative and of the hypothesized direction. As a result this hypothesis is generally supported

H.G.2) Hospital action increases organizational performance for HMO patients

Nine of the eleven models exhibit a significant coefficient on HMO% interacted with hospital action in the performance equation. In 8 of the 9 cases, this sign is positive and of the hypothesized direction. As a result this hypothesis is generally supported

H.H) Monitoring increases hospital performance

Five of the eleven models exhibit a significant coefficient on the effect of monitoring on hospital performance. In 3 of the 5 models the coefficient is positive consistent with the hypothesis. As a result the support for this hypothesis is equivocal.

H.I) Increases in HMO percentage decreases hospital performance.

Six of the eleven models exhibit a significant coefficient on the effect of HMO% on hospital performance. In 5 of the 6 models the coefficient is negative consistent with the hypothesis. As a result the preponderance of the evidence supports the hypothesis.

Figure 5.1 presents the percentage of hospital results for each variable in the system which is consistent with the hypothesized result. In conclusion there is support for a number of the study hypotheses. Hospital HMO% does appear to be reducing the level of resource intensive services, and there is some evidence suggesting that for-profit hospitals adjust their resource levels less than NFP hospitals. Monitoring does appear to affect hospital action, at times in a complementary fashion and in others as a substitute for reductions in hospital resource reductions.

While HMO% appears to systematically drive the behavior of hospitals (elasticities typically less than .5), the converse is not strongly supported. HMO% does not appear to respond consistently to NFP hospital action which would be anticipated to be in the direction desired by managed care plans. There is some evidence that FP hospital adjustment does lead to increases in HMO%. Monitoring increases hospital HMO% consistently. Additionally, the hospital action taken does affect the level of monitoring in the hospital.

Finally, while hospital action in most cases reduces hospital operating margins (elasticities of approximately 1 to 6) there is evidence that the effect is less in FP hospitals. Hospital action does however increase the returns attributable to the hospital's HMO population. Increasing HMO% overall significantly reduces hospital operating margins with elasticities typically in the range of .5 to 1.5.

## Table 5.1: Variable Means by Year

| Variable | Description | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | Change |
|---|---|---|---|---|---|---|---|---|
| **CAPACITY VARIABLES** | | | | | | | | |
| ACUPER | % of hosp beds acute care | 0.865 | 0.860 | 0.855 | 0.849 | 0.847 | 0.832 | -3.79% |
| INTNPER | % of hosp beds intensive care | 0.085 | 0.088 | 0.089 | 0.090 | 0.091 | 0.094 | 10.28% |
| SUBAPER | % of hosp beds subacute care | 0.015 | 0.015 | 0.017 | 0.029 | 0.022 | 0.031 | 113.55% |
| TOTBEDS | Licensed hospital beds | 301 | 303 | 303 | 306 | 308 | 314 | 4.24% |
| EMP4 | Tot. FTEs | 4,937 | 5,280 | 5,568 | 5,792 | 5,945 | 5,975 | 21.03% |
| EMP2 | Tot. amb staff members | 401 | 466 | 509 | 585 | 620 | 604 | 50.53% |
| MON23 | % of hospital FTEs in UR | 0.014 | 0.013 | 0.014 | 0.015 | 0.015 | 0.016 | 13.26% |
| **CAPITAL STRUCTURE** | | | | | | | | |
| BYEK | % of total capital disposed | 0.069 | 0.032 | 0.492 | 0.060 | 0.102 | 0.072 | 4.66% |
| NEWK | % of total capital added | 0.118 | 0.136 | 0.157 | 0.154 | 0.139 | 0.168 | 42.30% |
| KRAT | % Cap. Disp. / % Cap. Add. | 0.421 | 0.367 | 0.833 | 0.279 | 1.540 | 0.376 | -10.71% |
| NEW4K | Purchase of Fixed Equipt. | 0.013 | 0.009 | 0.045 | 0.009 | 0.011 | 0.013 | 1.28% |
| NEW6K | Purchase of Moveable Equipt. | 0.046 | 0.051 | 0.049 | 0.057 | 0.049 | 0.053 | 17.00% |
| **MARKET / HOSPITAL CHAR.** | | | | | | | | |
| HMOPER2 | HMO percentage | 0.091 | 0.146 | 0.171 | 0.188 | 0.210 | 0.227 | 149.13% |
| FPHMOPER | HMO % in FP hospitals | 0.039 | 0.077 | 0.092 | 0.105 | 0.117 | 0.120 | 206.87% |
| OPMARG | Hospital Operating Margin | -0.429 | 1.180 | 2.190 | 3.476 | 3.782 | 4.430 | -1131.61% |
| FPMON23 | FP * MON23 | 0.007 | 0.007 | 0.007 | 0.008 | 0.007 | 0.008 | 14.28% |
| FP | % of For-profit hospitals | 0.472 | 0.463 | 0.463 | 0.463 | 0.463 | 0.463 | -1.72% |
| SYSTEM | % of System hospitals | 0.407 | 0.398 | 0.398 | 0.423 | 0.390 | 0.382 | -6.00% |
| BED100 | % between 100 - 300 beds | 0.504 | 0.496 | 0.504 | 0.496 | 0.504 | 0.488 | -3.23% |
| BED300 | % greater than 300 beds | 0.390 | 0.390 | 0.390 | 0.398 | 0.390 | 0.415 | 6.25% |
| HHI | Market HHI | 0.192 | 0.187 | 0.188 | 0.185 | 0.180 | 0.210 | 9.06% |
| MHSHARE | System share of total adm. | 0.364 | 0.386 | 0.389 | 0.414 | 0.354 | 0.315 | -13.48% |
| FPSHARE | For-profit share of total adm. | 0.412 | 0.419 | 0.419 | 0.410 | 0.424 | 0.349 | -15.20% |
| MCDPER | Medicaid percentage of adm. | 0.062 | 0.072 | 0.076 | 0.087 | 0.094 | 0.100 | 60.84% |
| MCRPER | Medicare percentage of adm. | 0.446 | 0.450 | 0.455 | 0.466 | 0.470 | 0.475 | 6.66% |
| EXPBED | Expenses / Beds (x 1,000) | 159 | 181 | 199 | 210 | 226 | 233 | 46.64% |
| OCCRT | Occupancy rate | 0.542 | 0.549 | 0.540 | 0.531 | 0.528 | 0.532 | -1.93% |
| MAPER | HMO % in hospital market | 0.112 | 0.159 | 0.187 | 0.205 | 0.233 | 0.249 | 122.32% |
| MALPRAC | Malpractice ins exp. (x 1,000) | 1,167 | 1,054 | 1,036 | 951 | 1,007 | 1,062 | -9.02% |
| MANPROD | admiss/ FTEs | 1.728 | 1.689 | 1.598 | 1.547 | 1.544 | 1.584 | -8.33% |
| AMBPER | Ambulatory % | 0.041 | 0.043 | 0.047 | 0.050 | 0.054 | 0.050 | 23.42% |
| OUTPER | Outpatient % | 0.209 | 0.224 | 0.246 | 0.261 | 0.276 | 0.279 | 33.87% |

## Table 5.2a: Not For-Profit Change from 1989 - 1994

| Variable | Description | 1994 Level LOW | 1994 Level HIGH | Bottom Quartile | Top Quartile |
|---|---|---|---|---|---|
| HMOPER2 | HMO percentage | 10.07 | 33.80 | -1.92 | 30.76 |
| **CAPACITY VARIABLES** | | | | | |
| ACUPER | % of hosp beds acute care | 83.10 | 82.76 | .52 | -2.67 |
| INTNPER | % of hosp beds intensive care | 7.85 | 11.32 | -.40 | 1.6 |
| SUBAPER | % of hosp beds subacute care | 4.35 | .41 | -.19 | .17 |
| TOTBEDS | Licensed hospital beds | 298 | 361 | 3.55 | .88 |
| EMP4 | Tot. FTEs | 6212 | 7102 | 18.46 | 16.70 |
| EMP2 | Tot. amb staff members | 669 | 886 | 25.81 | 39.36 |
| MON23 | % of hospital FTEs in UR | .89 | 1.78 | -.04 | .15 |
| **CAPITAL STRUCTURE** | | | | | |
| BYEK | % of total capital disposed | 4.97 | 15.04 | .43 | 13.75 |
| NEWK | % of total capital added | 16.77 | 24.07 | 4.43 | 6.44 |
| KRAT | % Cap. Disp. / % Cap. Add. | 31.83 | 44.15 | 7.28 | 32.30 |
| NEW4K | Purchase of Fixed Equipt. | 2.06 | 1.82 | .05 | 1.22 |
| NEW6K | Purchase of Moveable Equipt. | 5.42 | 6.20 | .30 | -.19 |

## Table 5.2b: For- Profit Change from 1989 - 1994

| Variable | Description | 1994 Level LOW | 1994 Level HIGH | Bottom Quartile | Top Quartile |
|---|---|---|---|---|---|
| HMOPER2 | HMO percentage | 12.73 | 39.38 | .63 | 34.35 |
| **CAPACITY VARIABLES** | | | | | |
| ACUPER | % of hosp beds acute care | 87.22 | 83.49 | -2.83 | -3.55 |
| INTNPER | % of hosp beds intensive care | 8.30 | 9.03 | .82 | -.08 |
| SUBAPER | % of hosp beds subacute care | 2.33 | 2.64 | 2.33 | 1.94 |
| TOTBEDS | Licensed hospital beds | 214 | 245 | .16 | 5.48 |
| EMP4 | Tot. FTEs | 3359 | 3465 | 11.42 | 18.16 |
| EMP2 | Tot. amb staff members | 203 | 265 | 39.03 | 32.68 |
| MON23 | % of hospital FTEs in UR | 1.6 | 2.0 | -.18 | .27 |
| **CAPITAL STRUCTURE** | | | | | |
| BYEK | % of total capital disposed | 2.65 | 7.30 | -13.12 | -5.83 |
| NEWK | % of total capital added | 14.51 | 12.86 | -3.56 | 2.00 |
| KRAT | % Cap. Disp. / % Cap. Add. | 29.89 | 45.67 | -45.56 | -43.47 |
| NEW4K | Purchase of Fixed Equipt. | .67 | .74 | -.72 | -.16 |
| NEW6K | Purchase of Moveable Equipt. | 4.30 | 3.86 | -5.54 | -.38 |

## Table 5.3: Variable Standard Deviations by Year

| Variable | Description | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | Change | Mean |
|---|---|---|---|---|---|---|---|---|---|
| **CAPACITY VARIABLES** | | | | | | | | | |
| ACUPER | % of hosp beds acute care | 0.080 | 0.084 | 0.083 | 0.081 | 0.081 | 0.090 | 12.71% | 0.083 |
| INTNPER | % of hosp beds intensive care | 0.042 | 0.044 | 0.049 | 0.048 | 0.047 | 0.050 | 17.59% | 0.047 |
| SUBAPER | % of hosp beds subacute care | 0.055 | 0.055 | 0.057 | 0.107 | 0.060 | 0.078 | 43.07% | 0.069 |
| TOTBEDS | Licensed hospital beds | 214 | 216 | 223 | 224 | 229 | 233 | 8.74% | 223 |
| EMP4 | Tot. FTEs | 4,446 | 4,876 | 5,166 | 5,220 | 5,221 | 5,435 | 22.23% | 5,061 |
| EMP2 | Tot. amb staff members | 462 | 591 | 593 | 686 | 619 | 638 | 38.04% | 598 |
| MON23 | % of hospital FTEs in UR | 0.011 | 0.011 | 0.011 | 0.012 | 0.012 | 0.012 | 12.46% | 0.012 |
| **CAPITAL STRUCTURE** | | | | | | | | | |
| BYEK | % of total capital disposed | 0.195 | 0.081 | 4.516 | 0.181 | 0.490 | 0.139 | -28.88% | 0.934 |
| NEWK | % of total capital added | 0.128 | 0.162 | 0.399 | 0.187 | 0.151 | 0.166 | 29.63% | 0.199 |
| KRAT | % Cap. Disp. / % Cap. Add. | 1.166 | 1.921 | 4.103 | 0.427 | 7.806 | 0.441 | -62.12% | 2.644 |
| NEW4K | Purchase of Fixed Equipt. | 0.023 | 0.018 | 0.388 | 0.022 | 0.028 | 0.023 | -0.35% | 0.083 |
| NEW6K | Purchase of Moveable Equipt. | 0.059 | 0.052 | 0.061 | 0.057 | 0.047 | 0.047 | -21.35% | 0.054 |
| **MARKET / HOSPITAL CHAR.** | | | | | | | | | |
| HMOPER2 | HMO percentage | 0.120 | 0.139 | 0.141 | 0.154 | 0.165 | 0.159 | 32.86% | 0.146 |
| FPHMOPER | HMO % in FP hospitals | 0.100 | 0.134 | 0.146 | 0.167 | 0.184 | 0.180 | 79.41% | 0.152 |
| OPMARG | Hospital Operating Margin | 9.376 | 7.399 | 8.650 | 9.917 | 14.172 | 9.312 | -0.69% | 9.804 |
| FPMON23 | FP * MON23 | 0.012 | 0.011 | 0.011 | 0.013 | 0.012 | 0.012 | 1.26% | 0.012 |
| FP | % of For-profit hospitals | 0.501 | 0.501 | 0.501 | 0.501 | 0.501 | 0.501 | -0.11% | 0.501 |
| SYSTEM | % of System hospitals | 0.493 | 0.492 | 0.492 | 0.496 | 0.490 | 0.488 | -1.07% | 0.492 |
| BED100 | % between 100 - 300 beds | 0.502 | 0.502 | 0.502 | 0.502 | 0.502 | 0.502 | -0.03% | 0.502 |
| BED300 | % greater than 300 beds | 0.490 | 0.490 | 0.490 | 0.492 | 0.490 | 0.495 | 1.00% | 0.491 |
| HHI | Market HHI | 0.185 | 0.181 | 0.180 | 0.180 | 0.176 | 0.187 | 1.08% | 0.182 |
| MHSHARE | System share of total adm. | 0.245 | 0.242 | 0.249 | 0.271 | 0.241 | 0.258 | 5.20% | 0.251 |
| FPSHARE | For-profit share of total adm. | 0.241 | 0.235 | 0.234 | 0.217 | 0.226 | 0.245 | 1.47% | 0.233 |
| MCDPER | Medicaid percentage of adm. | 0.072 | 0.080 | 0.072 | 0.075 | 0.073 | 0.071 | -0.20% | 0.074 |
| MCRPER | Medicare percentage of adm. | 0.137 | 0.147 | 0.153 | 0.161 | 0.165 | 0.169 | 23.42% | 0.155 |
| EXPBED | Expenses / Beds (x 1,000) | 54 | 58 | 65 | 76 | 102 | 110 | 103.70% | 78 |
| OCCRT | Occupancy rate | 0.142 | 0.142 | 0.143 | 0.142 | 0.141 | 0.144 | 1.59% | 0.143 |
| MAPER | HMO % in hospital market | 0.056 | 0.079 | 0.082 | 0.079 | 0.090 | 0.086 | 52.64% | 0.079 |
| MALPRAC | Malpractice ins exp. (x 1,000) | 1,176 | 1,044 | 1,209 | 1,182 | 1,304 | 1,316 | 11.90% | 1,205 |
| MANPROD | admiss/ FTEs | 0.437 | 0.326 | 0.315 | 0.365 | 0.344 | 0.346 | -20.85% | 0.356 |
| AMBPER | Ambulatory % | 0.025 | 0.024 | 0.029 | 0.033 | 0.037 | 0.032 | 30.65% | 0.030 |
| OUTPER | Outpatient % | 0.070 | 0.072 | 0.080 | 0.082 | 0.084 | 0.090 | 29.58% | 0.080 |

## Table 5.4: Correlation Table of Independent Variables

| | HMOPER2 | FP*HMOPER2 | OPMARG | MON23 | FP | SYSTEM | BED100 | BED300 | HHI | MHSHARE | FPSHARE | INCOME | EDUCAT | MCDPER | DENSITY | MCRPER | EXPBED | OCCRT | MAPER | MALPRAC | MANPROD | AMBPER | OUTPER | FPMON23 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **HMOPER2** | 1 | | | | | | | | | | | | | | | | | | | | | | | |
| **FPHMOPER** | .71 | 1 | | | | | | | | | | | | | | | | | | | | | | |
| **OPMARG** | -.07 | -.06 | 1 | | | | | | | | | | | | | | | | | | | | | |
| **MON23** | .14 | .14 | .06 | 1 | | | | | | | | | | | | | | | | | | | | |
| **FP** | .15 | .63 | .07 | .18 | 1 | | | | | | | | | | | | | | | | | | | |
| **SYSTEM** | .06 | .33 | .20 | .16 | .55 | 1 | | | | | | | | | | | | | | | | | | |
| **BED100** | .02 | .36 | .02 | -.03 | .48 | .27 | 1 | | | | | | | | | | | | | | | | | |
| **BED300** | .08 | -.26 | .04 | .13 | -.43 | -.27 | -.26 | 1 | | | | | | | | | | | | | | | | |
| **HHI** | -.24 | -.16 | .09 | -.04 | -.12 | .06 | -.08 | -.01 | 1 | | | | | | | | | | | | | | | |
| **MHSHARE** | -.02 | .12 | .15 | .14 | .19 | .48 | .10 | -.10 | .06 | 1 | | | | | | | | | | | | | | |
| **FPSHARE** | .16 | .33 | .05 | .17 | .45 | .26 | .17 | -.14 | -.16 | .50 | 1 | | | | | | | | | | | | | |
| **INCOME** | .24 | .26 | .03 | .04 | .09 | -.03 | .05 | .11 | -.27 | -.08 | .13 | 1 | | | | | | | | | | | | |
| **EDUCAT** | .08 | .11 | .03 | .02 | .08 | .08 | .01 | .04 | .28 | .04 | .11 | .26 | 1 | | | | | | | | | | | |
| **MCDPER** | -.07 | -.18 | -.01 | .04 | -.19 | -.16 | -.21 | .20 | .22 | .02 | -.15 | -.19 | .04 | 1 | | | | | | | | | | |
| **DENSITY** | .08 | .07 | .01 | .02 | .11 | -.06 | .06 | .05 | -.48 | -.04 | .15 | .27 | .10 | -.13 | 1 | | | | | | | | | |
| **MCRPER** | -.61 | -.36 | .13 | -.11 | .05 | .07 | .11 | -.23 | .01 | .01 | .04 | .04 | -.14 | -.38 | .06 | 1 | | | | | | | | |
| **EXPBED** | .01 | -.12 | .11 | -.03 | -.20 | -.09 | -.09 | .06 | -.06 | -.15 | -.12 | .20 | -.06 | -.02 | -.06 | .02 | 1 | | | | | | | |
| **OCCRT** | -.12 | -.28 | .30 | -.02 | -.26 | -.12 | -.20 | .34 | .06 | -.15 | -.14 | .01 | -.07 | .11 | -.04 | .07 | .44 | 1 | | | | | | |
| **MAPER** | .53 | .34 | -.04 | .05 | .13 | -.06 | .00 | .02 | -.43 | -.04 | .21 | .32 | .15 | -.01 | .16 | -.18 | .15 | -.15 | 1 | | | | | |
| **MALPRAC** | .27 | -.07 | .01 | .15 | -.21 | -.15 | -.33 | .49 | -.09 | -.12 | -.04 | .02 | .04 | .18 | .03 | -.39 | .15 | .37 | .17 | 1 | | | | |
| **MANPROD** | .14 | .32 | .15 | .14 | .33 | .22 | .33 | -.23 | .06 | .14 | .17 | -.03 | .07 | .09 | .09 | -.25 | -.24 | -.08 | -.12 | -.11 | 1 | | | |
| **AMBPER** | -.05 | -.22 | -.14 | -.12 | -.44 | -.27 | -.18 | .09 | .14 | -.10 | -.29 | -.05 | .02 | .21 | -.10 | -.02 | .03 | -.04 | -.02 | .02 | -.19 | 1 | | |
| **OUTPER** | .08 | .01 | -.18 | -.09 | -.20 | -.16 | -.01 | -.20 | .16 | -.06 | -.19 | -.03 | .03 | .15 | -.20 | -.14 | .21 | -.40 | .14 | -.22 | -.06 | .50 | 1 | |
| **FPMON23** | .13 | .46 | .18 | .64 | .70 | .42 | .30 | -.25 | -.03 | .23 | .37 | .02 | .05 | -.07 | .05 | -.03 | -.15 | -.22 | -.05 | -.13 | .33 | -.32 | -.06 | 1 |

## Table 5.5: System Fit and Cross Model Correlation

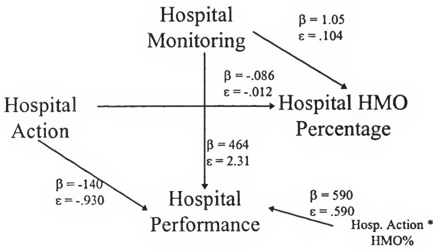
| **Equation #1: Hospital Action** | % Beds Subacute | % Beds Acute | % Beds Intensive Care | Total Licensed Beds | Total FTEs | Ambulatory Staff FTEs | Purch. Fixed Equiptment | Purch. Moveable Equipt. | % Capital Retired | % Capital Added | Ratio: Reitred / Added |
|---|---|---|---|---|---|---|---|---|---|---|---|
| System Weighted R-sq | .597 | .721 | .784 | .952 | .947 | .754 | .596 | .610 | .614 | .610 | .617 |
| Cross Model Correlation Action -Monitoring | .03 | .24 | -.25 | -.02 | -.13 | -.28 | -.23 | -.05 | -.18 | -.08 | .16 |

## Table 5.6 / Simultaneous Regression Model 1:

| Equation #1 | | **Percent Beds Alloc. to Subacute Care** | | | |
|---|---|---|---|---|---|
| **System Weighted R-Squared .597** | | **Beta** | **S.E.** | **Sig.** | |
| | INTERCEP | 0.179 | 0.205 | 0.382 | |
| Lagged Dependent Variable | LACTION | 0.614 | 0.036 | 0.000 | *** |
| **Lagged HMO Percentage** | LHMOPER2 | -0.002 | 0.030 | 0.958 | |
| **FP * Lagged HMO Percentage** | LFPHMOPE | -0.000 | 0.037 | 0.990 | |
| Lagged Operating Margin | LOPMARG | 0.000 | 0.000 | 0.762 | |
| **Monitoring** | MON32 | -0.264 | 1.460 | 0.857 | |
| **FP*Monitoring** | FPMON23 | -0.030 | 1.470 | 0.984 | |
| FP Dummy | FP | 0.015 | 0.020 | 0.461 | |
| System Dummy | SYSTEM | -0.010 | 0.008 | 0.200 | |
| Beds size 100 - 300 | BED100 | -0.006 | 0.010 | 0.513 | |
| Beds size > 300 | BED300 | -0.003 | 0.012 | 0.804 | |
| Market HHI | HHI | 0.006 | 0.017 | 0.723 | |
| MHS Share of Market | MHSHARE | 0.025 | 0.013 | 0.069 | * |
| FP Share of Market | FPSHARE | -0.035 | 0.015 | 0.017 | ** |
| Median Income | INCOME | -0.000 | 0.000 | 0.581 | |
| Median Years of Education | EDUCAT | -0.012 | 0.017 | 0.476 | |
| Equation #2 | | **HMO Percentage** | | | |
| | INTERCEP | 0.035 | 0.017 | 0.036 | ** |
| **Lagged Hospital Action** | LACTION | -0.086 | 0.054 | 0.110 | * |
| **FP * Lagged Hospital Action** | LFPACT | 0.042 | 0.080 | 0.599 | |
| **Monitoring** | MON32 | 1.047 | 0.572 | 0.068 | ** |
| **FP*Monitoring** | FPMON23 | 0.157 | 0.488 | 0.748 | |
| Lagged Dependent Variable | LHMOPER2 | 0.857 | 0.021 | 0.000 | *** |
| System Dummy | SYSTEM | 0.001 | 0.006 | 0.912 | |
| Lagged Occupancy Rate | LOCCRT | -0.025 | 0.021 | 0.236 | |
| Market HHI | HHI | -0.021 | 0.020 | 0.299 | |
| HMO % in Market | MAPER | 0.137 | 0.039 | 0.001 | *** |
| Hosptial Medicaid % | MCDPER | -0.104 | 0.039 | 0.008 | *** |
| Population density 1980 | DENSITY | -0.000 | 0.000 | 0.459 | |
| Equation #3 | | **Monitoring** | | | |
| | INTERCEP | 0.000 | 0.006 | 0.946 | |
| **Action** | ACTION | -0.007 | 0.007 | 0.296 | |
| **Hospital HMO percentage** | HMOPER2 | 0.003 | 0.006 | 0.549 | |
| Hospital Wage | W4 | -0.000 | 0.000 | 0.002 | *** |
| FP Dummy | FP | 0.005 | 0.001 | 0.000 | *** |
| Beds size 100 - 300 | BED100 | 0.001 | 0.002 | 0.423 | |
| Beds size > 300 | BED300 | 0.006 | 0.002 | 0.001 | *** |
| Hospital Ambulalory Percentage | AMBPER | -0.006 | 0.018 | 0.730 | |
| Hospital Outpatient Percentage | OUTPER | 0.001 | 0.007 | 0.854 | |
| Median Income of Market | INCOME | -0.000 | 0.000 | 0.968 | |
| Medicare Percentage | MCRPER | 0.002 | 0.005 | 0.707 | |
| Occupancy Rate | OCCRT | 0.001 | 0.004 | 0.882 | |
| Malpractice Insurance Expenses | MALPRAC | 0.000 | 0.000 | 0.008 | *** |
| Manpower Productivity | MANPROD | 0.007 | 0.002 | 0.001 | *** |
| Equation #4 | | **Operating Margin** | | | |
| | INTERCEP | -13.671 | 5.854 | 0.020 | ** |
| **Hospital Action** | ACTION | -139.564 | 80.444 | 0.083 | ** |
| **Monitoring** | MON32 | 463.464 | 279.349 | 0.098 | ** |
| **FP*Monitoring** | FPMON23 | -9.689 | 276.449 | 0.972 | |
| **FP * Hospital Action** | FPACT | 68.979 | 37.598 | 0.067 | ** |
| **HMO Percentage** | HMOPER2 | -6.478 | 7.769 | 0.405 | |
| **HMO % * Action** | HMOACT | 590.486 | 315.818 | 0.062 | ** |
| FP Dummy | FP | -4.347 | 3.813 | 0.255 | |
| System Dummy | SYSTEM | 5.310 | 1.255 | 0.000 | *** |
| Beds size 100 - 300 | BED100 | 1.548 | 2.172 | 0.477 | |
| Beds size > 300 | BED300 | -0.197 | 3.210 | 0.951 | |
| Market HHI | HHI | 6.076 | 3.246 | 0.062 | * |
| Hospital Medicare % | MCRPER | 15.363 | 7.913 | 0.053 | ** |
| Hospital Medicaid % | MCDPER | 14.983 | 13.767 | 0.277 | |
| Hospital expense / bed | EXPBED | 0.000 | 0.000 | 0.297 | |

Single tailed tests (**in bold**), two tailed tests for control variables. * Sig.t at .10 level, ** Sigt .05 level, *** Sig at .01 level

Figure 5.1 Subacute Care %

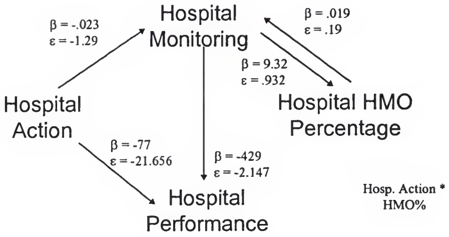


## Table 5.7 / Simultaneous Regression Model 2:

| Equation #1 | | Percent Beds Allocated to Acute Care | | | |
|---|---|---|---|---|---|
| **System Weighted R-Squared .721** | | **Beta** | **S.E.** | **Sig.** | |
| | INTERCEP | -0.104 | 0.126 | 0.412 | |
| Lagged Dependent Variable | LACTION | 0.916 | 0.020 | 0.000 | *** |
| **Lagged HMO Percentage** | LHMOPER2 | 0.001 | 0.020 | 0.948 | |
| **FP * Lagged HMO Percentage** | LFPHMOPE | 0.019 | 0.024 | 0.428 | |
| Lagged Operating Margin | LOPMARG | -0.001 | 0.000 | 0.000 | *** |
| **Monitoring** | MON32 | -1.143 | 0.927 | 0.218 | |
| **FP*Monitoring** | FPMON23 | 0.545 | 0.929 | 0.558 | |
| FP Dummy | FP | -0.010 | 0.012 | 0.415 | |
| System Dummy | SYSTEM | 0.005 | 0.005 | 0.296 | |
| Beds size 100 - 300 | BED100 | -0.001 | 0.006 | 0.804 | |
| Beds size > 300 | BED300 | 0.003 | 0.008 | 0.706 | |
| Market HHI | HHI | -0.015 | 0.010 | 0.134 | |
| MHS Share of Market | MHSHARE | 0.001 | 0.008 | 0.909 | |
| FP Share of Market | FPSHARE | 0.002 | 0.009 | 0.836 | |
| Median Income | INCOME | -0.000 | 0.000 | 0.107 | |
| Median Years of Education | EDUCAT | 0.016 | 0.010 | 0.121 | |
| Equation #2 | | **HMO Percentage** | | | |
| | INTERCEP | 0.034 | 0.048 | 0.483 | |
| **Lagged Hospital Action** | LACTION | -0.058 | 0.047 | 0.216 | |
| **FP * Lagged Hospital Action** | LFPACT | 0.085 | 0.024 | 0.000 | *** |
| **Monitoring** | MON32 | 9.323 | 1.363 | 0.000 | *** |
| **FP*Monitoring** | FPMON23 | -5.295 | 1.387 | 0.000 | *** |
| Lagged Dependent Variable | LHMOPER2 | 0.762 | 0.028 | 0.000 | *** |
| System Dummy | SYSTEM | -0.015 | 0.008 | 0.077 | * |
| Lagged Occupancy Rate | LOCCRT | -0.070 | 0.028 | 0.015 | ** |
| Market HHI | HHI | -0.010 | 0.024 | 0.657 | |
| HMO % in Market | MAPER | 0.100 | 0.048 | 0.037 | ** |
| Hosptial Medicaid % | MCDPER | -0.185 | 0.049 | 0.000 | *** |
| Population density 1980 | DENSITY | -0.000 | 0.000 | 0.095 | * |
| Equation #3 | | **Monitoring** | | | |
| | INTERCEP | 0.021 | 0.008 | 0.008 | *** |
| **Action** | ACTION | -0.023 | 0.008 | 0.002 | *** |
| **Hospital HMO percentage** | HMOPER2 | 0.019 | 0.004 | 0.000 | *** |
| Hospital Wage | W4 | -0.000 | 0.000 | 0.147 | |
| FP Dummy | FP | 0.005 | 0.001 | 0.000 | *** |
| Beds size 100 - 300 | BED100 | 0.002 | 0.002 | 0.113 | |
| Beds size > 300 | BED300 | 0.006 | 0.002 | 0.001 | *** |
| Hospital Ambulatory Percentage | AMBPER | 0.004 | 0.016 | 0.817 | |
| Hospital Outpatient Percentage | OUTPER | 0.000 | 0.007 | 0.965 | |
| Median Income of Market | INCOME | -0.000 | 0.000 | 0.294 | |
| Medicare Percentage | MCRPER | 0.003 | 0.004 | 0.421 | |
| Occupancy Rate | OCCRT | -0.002 | 0.004 | 0.664 | |
| Malpractice Insurance Expenses | MALPRAC | 0.000 | 0.000 | 0.260 | |
| Manpower Productivity | MANPROD | 0.004 | 0.001 | 0.004 | *** |
| Equation #4 | | **Operating Margin** | | | |
| | INTERCEP | 53.124 | 25.821 | 0.040 | ** |
| **Hospital Action** | ACTION | -77.343 | 29.652 | 0.009 | *** |
| **Monitoring** | MON32 | -429.417 | 300.081 | 0.153 | * |
| **FP*Monitoring** | FPMON23 | 398.763 | 301.040 | 0.186 | * |
| **FP * Hospital Action** | FPACT | 42.369 | 25.486 | 0.097 | ** |
| **HMO Percentage** | HMOPER2 | 57.937 | 93.119 | 0.534 | |
| **HMO % * Action** | HMOACT | -64.502 | 104.016 | 0.535 | |
| FP Dummy | FP | -37.960 | 23.525 | 0.107 | |
| System Dummy | SYSTEM | 3.805 | 1.144 | 0.001 | *** |
| Beds size 100 - 300 | BED100 | 6.642 | 1.821 | 0.000 | *** |
| Beds size > 300 | BED300 | 8.726 | 2.370 | 0.000 | *** |
| Market HHI | HHI | 1.814 | 2.803 | 0.518 | |
| Hospital Medicare % | MCRPER | 15.210 | 5.471 | 0.006 | *** |
| Hospital Medicaid % | MCDPER | -11.220 | 9.111 | 0.219 | |
| Hospital expense / bed | EXPBED | 0.000 | 0.000 | 0.002 | *** |

Single tailed tests (**in bold**), two tailed tests for control variables. * Sig.t at .10 level, ** Sigt .05 level, *** Sig at .01 level

Figure 5.2 Acute Care %

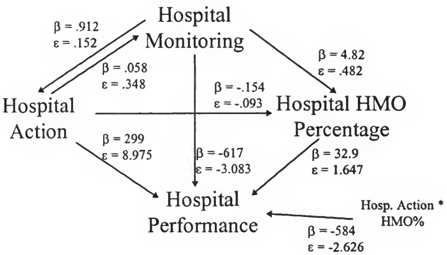


# Table 5.8 / Simultaneous Regression Model 3:

| Equation #1 | Percent Beds Alloc. To Intensive Care | | | | |
|---|---|---|---|---|---|
| **System Weighted R-Squared .784** | | **Beta** | **S.E.** | **Sig.** | |
| | INTERCEP | -0.052 | 0.056 | 0.349 | |
| Lagged Dependent Variable | LACTION | 0.937 | 0.016 | 0.000 | *** |
| **Lagged HMO Percentage** | LHMOPER2 | -0.005 | 0.009 | 0.609 | |
| **FP * Lagged HMO Percentage** | LFPHMOPE | -0.004 | 0.011 | 0.730 | |
| Lagged Operating Margin | LOPMARG | 0.000 | 0.000 | 0.000 | *** |
| **Monitoring** | MON32 | 0.912 | 0.380 | 0.017 | *** |
| **FP*Monitoring** | FPMON23 | -0.491 | 0.382 | 0.199 | * |
| FP Dummy | FP | 0.001 | 0.005 | 0.824 | |
| System Dummy | SYSTEM | -0.002 | 0.002 | 0.260 | |
| Beds size 100 - 300 | BED100 | -0.003 | 0.003 | 0.352 | |
| Beds size > 300 | BED300 | -0.008 | 0.003 | 0.015 | ** |
| Market HHI | HHI | 0.003 | 0.005 | 0.579 | |
| MHS Share of Market | MHSHARE | -0.002 | 0.004 | 0.668 | |
| FP Share of Market | FPSHARE | 0.007 | 0.004 | 0.058 | * |
| Median Income | INCOME | 0.000 | 0.000 | 0.175 | |
| Median Years of Education | EDUCAT | 0.004 | 0.005 | 0.415 | |
| Equation #2 | **HMO Percentage** | | | | |
| | INTERCEP | 0.022 | 0.018 | 0.212 | |
| **Lagged Hospital Action** | LACTION | -0.154 | 0.098 | 0.119 | * |
| **FP * Lagged Hospital Action** | LFPACT | 0.220 | 0.131 | 0.092 | ** |
| **Monitoring** | MON32 | 4.822 | 0.922 | 0.000 | *** |
| **FP*Monitoring** | FPMON23 | -1.983 | 0.910 | 0.030 | ** |
| Lagged Dependent Variable | LHMOPER2 | 0.819 | 0.023 | 0.000 | *** |
| System Dummy | SYSTEM | -0.003 | 0.007 | 0.683 | |
| Lagged Occupancy Rate | LOCCRT | -0.043 | 0.024 | 0.072 | * |
| Market HHI | HHI | -0.018 | 0.020 | 0.387 | |
| HMO % in Market | MAPER | 0.134 | 0.041 | 0.001 | *** |
| Hosptial Medicaid % | MCDPER | -0.138 | 0.041 | 0.001 | *** |
| Population density 1980 | DENSITY | -0.000 | 0.000 | 0.188 | |
| Equation #3 | **Monitoring** | | | | |
| | INTERCEP | 0.003 | 0.005 | 0.562 | |
| **Action** | ACTION | 0.058 | 0.013 | 0.000 | *** |
| **Hospital HMO percentage** | HMOPER2 | 0.006 | 0.005 | 0.263 | |
| Hospital Wage | W4 | -0.000 | 0.000 | 0.117 | |
| FP Dummy | FP | 0.006 | 0.001 | 0.000 | *** |
| Beds size 100 - 300 | BED100 | 0.002 | 0.002 | 0.170 | |
| Beds size > 300 | BED300 | 0.007 | 0.002 | 0.000 | *** |
| Hospital Ambulatory Percentage | AMBPER | -0.002 | 0.016 | 0.903 | |
| Hospital Outpatient Percentage | OUTPER | 0.003 | 0.007 | 0.697 | |
| Median Income of Market | INCOME | -0.000 | 0.000 | 0.284 | |
| Medicare Percentage | MCRPER | -0.005 | 0.005 | 0.333 | |
| Occupancy Rate | OCCRT | -0.005 | 0.004 | 0.198 | |
| Malpractice Insurance Expenses | MALPRAC | 0.000 | 0.000 | 0.167 | |
| Manpower Productivity | MANPROD | 0.004 | 0.001 | 0.002 | *** |
| Equation #4 | **Operating Margin** | | | | |
| | INTERCEP | -19.722 | 6.622 | 0.003 | *** |
| **Hospital Action** | ACTION | 299.158 | 56.465 | 0.000 | *** |
| **Monitoring** | MON32 | -616.534 | 292.831 | 0.036 | ** |
| **FP*Monitoring** | FPMON23 | 588.597 | 294.363 | 0.046 | ** |
| **FP * Hospital Action** | FPACT | -109.170 | 34.659 | 0.002 | *** |
| **HMO Percentage** | HMOPER2 | 32.936 | 18.859 | 0.081 | ** |
| **HMO % * Action** | HMOACT | -583.947 | 197.222 | 0.003 | *** |
| FP Dummy | FP | 4.946 | 3.379 | 0.144 | |
| System Dummy | SYSTEM | 4.985 | 1.133 | 0.000 | *** |
| Beds size 100 - 300 | BED100 | 2.866 | 1.648 | 0.083 | * |
| Beds size > 300 | BED300 | 6.029 | 2.138 | 0.005 | *** |
| Market HHI | HHI | 4.076 | 2.972 | 0.171 | |
| Hospital Medicare % | MCRPER | -3.650 | 5.893 | 0.536 | |
| Hospital Medicaid % | MCDPER | -2.387 | 8.412 | 0.777 | |
| Hospital expense / bed | EXPBED | 0.000 | 0.000 | 0.133 | |

Single tailed tests (**in bold**), two tailed tests for control variables. * Sig.t at .10 level, ** Sigt .05 level, *** Sig at .01 level

Figure 5.3 Intensive Care %

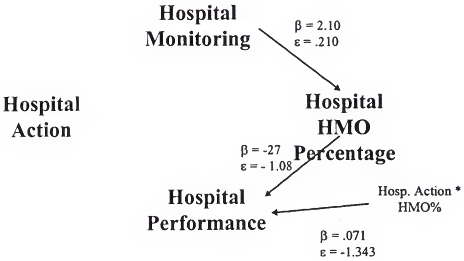


# Table 5.9 / Simultaneous Regression Model 4:

| Equation #1 | Licensed Beds | | | | |
|---|---|---|---|---|---|
| **System Weighted R-Squared .952** | | **Beta** | **S.E.** | **Sig.** | |
| | INTERCEP | 4.262 | 91.395 | 0.963 | |
| Lagged Dependent Variable | LACTION | 0.999 | 0.009 | 0.000 | *** |
| **Lagged HMO Percentage** | LHMOPER2 | 12.469 | 14.329 | 0.385 | |
| **FP * Lagged HMO Percentage** | LFPHMOPE | -19.516 | 17.175 | 0.256 | |
| Lagged Operating Margin | LOPMARG | 0.267 | 0.112 | 0.018 | *** |
| **Monitoring** | MON32 | -185.242 | 608.200 | 0.761 | |
| **FP*Monitoring** | FPMON23 | 244.879 | 616.031 | 0.691 | |
| FP Dummy | FP | 5.137 | 8.040 | 0.523 | |
| System Dummy | SYSTEM | -2.540 | 3.442 | 0.461 | |
| Beds size 100 - 300 | BED100 | -1.951 | 4.273 | 0.648 | |
| Beds size > 300 | BED300 | 6.121 | 5.608 | 0.276 | |
| Market HHI | HHI | -1.098 | 7.367 | 0.882 | |
| MHS Share of Market | MHSHARE | -0.972 | 5.864 | 0.868 | |
| FP Share of Market | FPSHARE | -6.646 | 6.387 | 0.299 | |
| Median Income | INCOME | 0.000 | 0.000 | 0.697 | |
| Median Years of Education | EDUCAT | -0.299 | 7.577 | 0.969 | |
| Equation #2 | | **HMO Percentage** | | | |
| | INTERCEP | 0.038 | 0.017 | 0.026 | ** |
| **Lagged Hospital Action** | LACTION | 0.000 | 0.000 | 0.257 | |
| **FP * Lagged Hospital Action** | LFPACT | 0.000 | 0.000 | 0.154 | * |
| **Monitoring** | MON32 | 2.095 | 1.026 | 0.042 | ** |
| **FP*Monitoring** | FPMON23 | -0.677 | 1.006 | 0.501 | |
| Lagged Dependent Variable | LHMOPER2 | 0.837 | 0.022 | 0.000 | *** |
| System Dummy | SYSTEM | 0.000 | 0.007 | 0.990 | |
| Lagged Occupancy Rate | LOCCRT | -0.051 | 0.022 | 0.023 | ** |
| Market HHI | HHI | -0.027 | 0.020 | 0.182 | |
| HMO % in Market | MAPER | 0.111 | 0.041 | 0.007 | *** |
| Hosptial Medicaid % | MCDPER | -0.129 | 0.038 | 0.001 | *** |
| Population density 1980 | DENSITY | -0.000 | 0.000 | 0.261 | |
| Equation #3 | | **Monitoring** | | | |
| | INTERCEP | -0.002 | 0.006 | 0.702 | |
| **Action** | ACTION | 0.000 | 0.000 | 0.355 | |
| **Hospital HMO percentage** | HMOPER2 | 0.007 | 0.006 | 0.243 | |
| Hospital Wage | W4 | -0.000 | 0.000 | 0.003 | *** |
| FP Dummy | FP | 0.005 | 0.001 | 0.000 | *** |
| Beds size 100 - 300 | BED100 | 0.001 | 0.002 | 0.533 | |
| Beds size > 300 | BED300 | 0.005 | 0.003 | 0.098 | * |
| Hospital Ambulatory Percentage | AMBPER | -0.008 | 0.018 | 0.634 | |
| Hospital Outpatient Percentage | OUTPER | 0.004 | 0.007 | 0.552 | |
| Median Income of Market | INCOME | 0.000 | 0.000 | 0.953 | |
| Medicare Percentage | MCRPER | 0.003 | 0.005 | 0.535 | |
| Occupancy Rate | OCCRT | -0.000 | 0.004 | 0.943 | |
| Malpractice Insurance Expenses | MALPRAC | 0.000 | 0.000 | 0.081 | * |
| Manpower Productivity | MANPROD | 0.007 | 0.002 | 0.0001 | *** |
| Equation #4 | | **Operating Margin** | | | |
| | INTERCEP | -7.636 | 5.488 | 0.165 | |
| **Hospital Action** | ACTION | -0.017 | 0.019 | 0.374 | |
| **Monitoring** | MON32 | 118.166 | 273.250 | 0.666 | |
| **FP*Monitoring** | FPMON23 | 138.502 | 275.239 | 0.615 | |
| **FP * Hospital Action** | FPACT | 0.011 | 0.007 | 0.149 | * |
| **HMO Percentage** | HMOPER2 | -26.864 | 14.635 | 0.067 | ** |
| **HMO % * Action** | HMOACT | 0.071 | 0.056 | 0.203 | * |
| FP Dummy | FP | -4.820 | 2.895 | 0.097 | * |
| System Dummy | SYSTEM | 4.905 | 1.091 | 0.000 | *** |
| Beds size 100 - 300 | BED100 | 5.792 | 2.654 | 0.030 | ** |
| Beds size > 300 | BED300 | 6.824 | 5.285 | 0.197 | |
| Market HHI | HHI | 5.139 | 3.141 | 0.102 | * |
| Hospital Medicare % | MCRPER | 8.456 | 5.430 | 0.120 | |
| Hospital Medicaid % | MCDPER | -1.356 | 7.792 | 0.862 | |
| Hospital expense / bed | EXPBED | 0.000 | 0.000 | 0.012 | *** |

Single tailed tests (**in bold**), two tailed tests for control variables. * Sig.t at .10 level, ** Sigt .05 level, *** Sig at .01 level

Figure 5.4 Total Licensed Beds

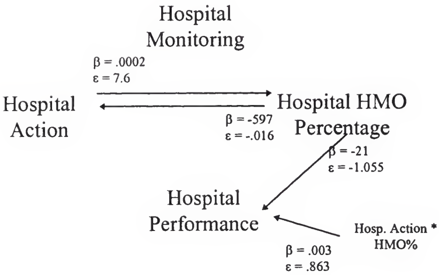


# Table 5.10 / Simultaneous Regression System 5:

| | | | | | |
|---|---|---|---|---|---|
| Equation #1 | Total FTEs | | | | |
| **System Weighted R-Squared .947** | | Beta | S.E. | Sig. | |
| | INTERCEP | -1597.702 | 2223.560 | 0.473 | |
| Lagged Dependent Variable | LACTION | 1.018 | 0.009 | 0.000 | *** |
| **Lagged HMO Percentage** | LHMOPER2 | -596.541 | 343.038 | 0.083 | ** |
| **FP * Lagged HMO Percentage** | LFPHMOPE | 434.212 | 413.759 | 0.294 | |
| Lagged Operating Margin | LOPMARG | 4.867 | 2.805 | 0.083 | ** |
| **Monitoring** | MON32 | 14409.000 | 15919.000 | 0.366 | |
| **FP*Monitoring** | FPMON23 | -8029.011 | 16102.000 | 0.618 | |
| FP Dummy | FP | -100.546 | 208.783 | 0.630 | |
| System Dummy | SYSTEM | 82.277 | 85.340 | 0.335 | |
| Beds size 100 - 300 | BED100 | 50.428 | 104.975 | 0.631 | |
| Beds size > 300 | BED300 | 90.453 | 133.021 | 0.497 | |
| Market HHI | HHI | -133.164 | 184.710 | 0.471 | |
| MHS Share of Market | MHSHARE | -204.778 | 144.388 | 0.157 | |
| FP Share of Market | FPSHARE | -32.258 | 159.410 | 0.840 | |
| Median Income | INCOME | -0.017 | 0.007 | 0.018 | ** |
| Median Years of Education | EDUCAT | 163.249 | 184.398 | 0.376 | |
| Equation #2 | | HMO Percentage | | | |
| | INTERCEP | 0.048 | 0.018 | 0.006 | *** |
| **Lagged Hospital Action** | LACTION | 0.000 | 0.000 | 0.053 | ** |
| **FP * Lagged Hospital Action** | LFPACT | 0.000 | 0.000 | 0.512 | |
| Monitoring | MON32 | 0.679 | 0.904 | 0.453 | |
| FP*Monitoring | FPMON23 | 0.332 | 0.871 | 0.703 | |
| Lagged Dependent Variable | LHMOPER2 | 0.844 | 0.022 | 0.000 | *** |
| System Dummy | SYSTEM | 0.001 | 0.007 | 0.851 | |
| Lagged Occupancy Rate | LOCCRT | -0.051 | 0.024 | 0.032 | ** |
| Market HHI | HHI | -0.029 | 0.020 | 0.138 | |
| HMO % in Market | MAPER | 0.124 | 0.041 | 0.002 | *** |
| Hosptial Medicaid % | MCDPER | -0.123 | 0.038 | 0.001 | *** |
| Population density 1980 | DENSITY | -0.000 | 0.000 | 0.418 | |
| Equation #3 | | Monitoring | | | |
| | INTERCEP | 0.000 | 0.006 | 0.967 | |
| **Action** | ACTION | 0.000 | 0.000 | 0.255 | |
| **Hospital HMO percentage** | HMOPER2 | 0.003 | 0.005 | 0.581 | |
| Hospital Wage | W4 | -0.000 | 0.000 | 0.002 | *** |
| FP Dummy | FP | 0.006 | 0.001 | 0.000 | *** |
| Beds size 100 - 300 | BED100 | 0.002 | 0.002 | 0.397 | |
| Beds size > 300 | BED300 | 0.005 | 0.002 | 0.023 | ** |
| Hospital Ambulatory Percentage | AMBPER | -0.005 | 0.018 | 0.768 | |
| Hospital Outpatient Percentage | OUTPER | 0.004 | 0.008 | 0.559 | |
| Median Income of Market | INCOME | 0.000 | 0.000 | 0.837 | |
| Medicare Percentage | MCRPER | 0.002 | 0.005 | 0.674 | |
| Occupancy Rate | OCCRT | -0.002 | 0.004 | 0.626 | |
| Malpractice Insurance Expenses | MALPRAC | 0.000 | 0.000 | 0.091 | * |
| Manpower Productivity | MANPROD | 0.006 | 0.002 | 0.0001 | *** |
| Equation #4 | | Operating Margin | | | |
| | INTERCEP | -5.194 | 4.945 | 0.294 | |
| **Hospital Action** | ACTION | -0.001 | 0.001 | 0.252 | |
| **Monitoring** | MON32 | -1.716 | 249.804 | 0.995 | |
| **FP*Monitoring** | FPMON23 | 180.168 | 251.617 | 0.474 | |
| **FP * Hospital Action** | FPACT | 0.002 | 0.000 | 0.000 | *** |
| **HMO Percentage** | HMOPER2 | -21.093 | 8.460 | 0.013 | *** |
| **HMO % * Action** | HMOACT | 0.003 | 0.002 | 0.050 | ** |
| FP Dummy | FP | -8.611 | 2.865 | 0.003 | *** |
| System Dummy | SYSTEM | 4.702 | 1.044 | 0.000 | *** |
| Beds size 100 - 300 | BED100 | 5.163 | 2.024 | 0.011 | *** |
| Beds size > 300 | BED300 | 4.725 | 3.499 | 0.177 | |
| Market HHI | HHI | 4.637 | 3.136 | 0.140 | |
| Hospital Medicare % | MCRPER | 8.095 | 5.314 | 0.128 | |
| Hospital Medicaid % | MCDPER | -1.084 | 7.443 | 0.884 | |
| Hospital expense / bed | EXPBED | 0.000 | 0.000 | 0.265 | |

Single tailed tests (**in bold**), two tailed tests for control variables. * Sig.t at .10 level, ** Sigt .05 level, *** Sig at .01 level

Figure 5.5 Total FTEs



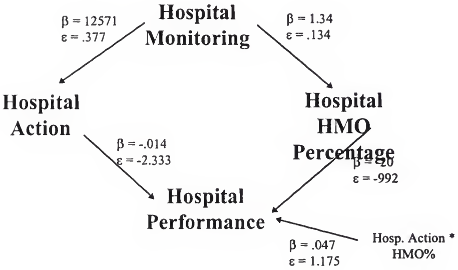
## Table 5.11 / Simultaneous Regression System 6:

Equation #1 **Ambulatory Staff FTEs**

| **System Weighted R-Squared .754** | | **Beta** | **S.E.** | **Sig.** | |
|---|---|---|---|---|---|
| | INTERCEP | -1657.831 | 802.281 | 0.039 | ** |
| Lagged Dependent Variable | LACTION | 0.876 | 0.023 | 0.000 | *** |
| **Lagged HMO Percentage** | LHMOPER2 | 83.884 | 123.683 | 0.498 | |
| **FP * Lagged HMO Percentage** | LFPHMOPE | -118.983 | 149.621 | 0.427 | |
| Lagged Operating Margin | LOPMARG | -1.773 | 0.996 | 0.076 | ** |
| **Monitoring** | MON32 | 12571.000 | 5911.756 | 0.034 | ** |
| **FP*Monitoring** | FPMON23 | -6465.067 | 5943.984 | 0.277 | |
| FP Dummy | FP | -8.355 | 76.431 | 0.913 | |
| System Dummy | SYSTEM | -9.326 | 30.937 | 0.763 | |
| Beds size 100 - 300 | BED100 | 29.479 | 39.041 | 0.451 | |
| Beds size > 300 | BED300 | 69.982 | 48.308 | 0.148 | |
| Market HHI | HHI | 0.798 | 67.463 | 0.991 | |
| MHS Share of Market | MHSHARE | 5.001 | 52.415 | 0.924 | |
| FP Share of Market | FPSHARE | -26.597 | 57.880 | 0.646 | |
| Median Income | INCOME | -0.004 | 0.003 | 0.121 | |
| Median Years of Education | EDUCAT | 135.998 | 66.494 | 0.041 | ** |
| Equation #2 | | **HMO Percentage** | | | |
| | INTERCEP | 0.039 | 0.017 | 0.023 | ** |
| **Lagged Hospital Action** | LACTION | 0.000 | 0.000 | 0.456 | |
| **FP * Lagged Hospital Action** | LFPACT | 0.000 | 0.000 | 0.269 | |
| **Monitoring** | MON32 | 1.338 | 0.769 | 0.082 | ** |
| **FP*Monitoring** | FPMON23 | -0.156 | 0.737 | 0.832 | |
| Lagged Dependent Variable | LHMOPER2 | 0.849 | 0.022 | 0.000 | *** |
| System Dummy | SYSTEM | 0.001 | 0.006 | 0.935 | |
| Lagged Occupancy Rate | LOCCRT | -0.035 | 0.023 | 0.118 | |
| Market HHI | HHI | -0.028 | 0.020 | 0.155 | |
| HMO % in Market | MAPER | 0.124 | 0.040 | 0.002 | *** |
| Hosptial Medicaid % | MCDPER | -0.124 | 0.039 | 0.001 | *** |
| Population density 1980 | DENSITY | -0.000 | 0.000 | 0.408 | |
| Equation #3 | | **Monitoring** | | | |
| | INTERCEP | 0.001 | 0.006 | 0.859 | |
| **Action** | ACTION | 0.000 | 0.000 | 0.000 | *** |
| **Hospital HMO percentage** | HMOPER2 | 0.003 | 0.005 | 0.585 | |
| Hospital Wage | W4 | -0.000 | 0.000 | 0.006 | *** |
| FP Dummy | FP | 0.007 | 0.001 | 0.000 | *** |
| Beds size 100 - 300 | BED100 | 0.001 | 0.002 | 0.739 | |
| Beds size > 300 | BED300 | 0.004 | 0.002 | 0.099 | * |
| Hospital Ambulatory Percentage | AMBPER | -0.005 | 0.019 | 0.780 | |
| Hospital Outpatient Percentage | OUTPER | 0.000 | 0.007 | 0.992 | |
| Median Income of Market | INCOME | 0.000 | 0.000 | 0.873 | |
| Medicare Percentage | MCRPER | 0.001 | 0.005 | 0.878 | |
| Occupancy Rate | OCCRT | -0.003 | 0.004 | 0.540 | |
| Malpractice Insurance Expenses | MALPRAC | 0.000 | 0.000 | 0.347 | |
| Manpower Productivity | MANPROD | 0.006 | 0.002 | 0.01 | *** |
| Equation #4 | | **Operating Margin** | | | |
| | INTERCEP | -11.983 | 5.544 | 0.031 | ** |
| **Hospital Action** | ACTION | -0.014 | 0.003 | 0.000 | *** |
| **Monitoring** | MON32 | 125.298 | 260.895 | 0.631 | |
| **FP*Monitoring** | FPMON23 | 114.417 | 263.748 | 0.665 | |
| **FP * Hospital Action** | FPACT | 0.006 | 0.004 | 0.203 | * |
| **HMO Percentage** | HMOPER2 | -19.836 | 7.671 | 0.010 | *** |
| **HMO % * Action** | HMOACT | 0.047 | 0.011 | 0.000 | *** |
| FP Dummy | FP | -5.671 | 3.185 | 0.076 | * |
| System Dummy | SYSTEM | 4.783 | 1.095 | 0.000 | *** |
| Beds size 100 - 300 | BED100 | 7.792 | 1.846 | 0.000 | *** |
| Beds size > 300 | BED300 | 9.409 | 2.607 | 0.000 | *** |
| Market HHI | HHI | 8.546 | 2.991 | 0.004 | *** |
| Hospital Medicare % | MCRPER | 12.479 | 5.977 | 0.037 | *** |
| Hospital Medicaid % | MCDPER | 4.062 | 8.256 | 0.623 | |
| Hospital expense / bed | EXPBED | 0.000 | 0.000 | 0.003 | *** |

Single tailed tests (in bold), two tailed tests for control variables. * Sig.t at .10 level, ** Sigt .05 level, *** Sig at .01 level

Figure 5.8 Ambulatory Staff FTEs



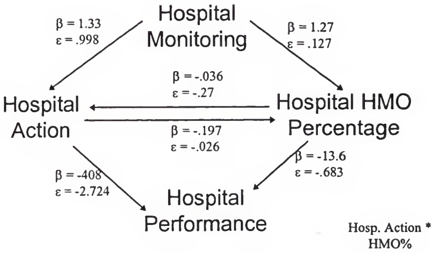
## Table 5.12 / Simultaneous Regression System 7:

Equation #1 **Purchase of Fixed Equiptment**

| **System Weighted R-Squared** | **.596** | **Beta** | **S.E.** | **Sig.** | |
|---|---|---|---|---|---|
| | INTERCEP | 0.124 | 0.087 | 0.155 | |
| Lagged Dependent Variable | LACTION | 0.000 | 0.006 | 0.956 | |
| **Lagged HMO Percentage** | LHMOPER2 | -0.036 | 0.013 | 0.004 | *** |
| **FP * Lagged HMO Percentage** | LFPHMOPE | 0.029 | 0.016 | 0.067 | ** |
| Lagged Operating Margin | LOPMARG | -0.001 | 0.000 | 0.000 | *** |
| **Monitoring** | MON32 | 1.331 | 0.684 | 0.052 | ** |
| **FP*Monitoring** | FPMON23 | -0.717 | 0.686 | 0.297 | |
| FP Dummy | FP | -0.008 | 0.009 | 0.352 | |
| System Dummy | SYSTEM | 0.004 | 0.003 | 0.221 | |
| Beds size 100 - 300 | BED100 | -0.005 | 0.004 | 0.235 | |
| Beds size > 300 | BED300 | -0.014 | 0.006 | 0.016 | ** |
| Market HHI | HHI | 0.008 | 0.008 | 0.311 | |
| MHS Share of Market | MHSHARE | -0.005 | 0.006 | 0.369 | |
| FP Share of Market | FPSHARE | 0.000 | 0.006 | 0.995 | |
| Median Income | INCOME | 0.000 | 0.000 | 0.156 | |
| Median Years of Education | EDUCAT | -0.010 | 0.007 | 0.188 | |
| Equation #2 | | **HMO Percentage** | | | |
| | INTERCEP | 0.032 | 0.017 | 0.053 | ** |
| **Lagged Hospital Action** | LACTION | -0.197 | 0.143 | 0.168 | * |
| **FP * Lagged Hospital Action** | LFPACT | 0.215 | 0.144 | 0.135 | * |
| **Monitoring** | MON32 | 1.274 | 0.577 | 0.028 | ** |
| **FP*Monitoring** | FPMON23 | 0.007 | 0.482 | 0.989 | |
| Lagged Dependent Variable | LHMOPER2 | 0.850 | 0.021 | 0.000 | *** |
| System Dummy | SYSTEM | 0.001 | 0.006 | 0.909 | |
| Lagged Occupancy Rate | LOCCRT | -0.027 | 0.021 | 0.202 | |
| Market HHI | HHI | -0.017 | 0.020 | 0.372 | |
| HMO % in Market | MAPER | 0.155 | 0.039 | 0.000 | *** |
| Hosptial Medicaid % | MCDPER | -0.120 | 0.039 | 0.002 | *** |
| Population density 1980 | DENSITY | -0.000 | 0.000 | 0.494 | |
| Equation #3 | | **Monitoring** | | | |
| | INTERCEP | -0.002 | 0.006 | 0.770 | |
| **Action** | ACTION | 0.104 | 0.026 | 0.000 | *** |
| **Hospital HMO percentage** | HMOPER2 | 0.003 | 0.006 | 0.549 | |
| Hospital Wage | W4 | -0.000 | 0.000 | 0.004 | *** |
| FP Dummy | FP | 0.006 | 0.001 | 0.000 | *** |
| Beds size 100 - 300 | BED100 | 0.002 | 0.002 | 0.178 | |
| Beds size > 300 | BED300 | 0.008 | 0.002 | 0.000 | *** |
| Hospital Ambulatory Percentage | AMBPER | -0.004 | 0.018 | 0.802 | |
| Hospital Outpatient Percentage | OUTPER | 0.002 | 0.007 | 0.799 | |
| Median Income of Market | INCOME | 0.000 | 0.000 | 0.970 | |
| Medicare Percentage | MCRPER | 0.002 | 0.005 | 0.757 | |
| Occupancy Rale | OCCRT | -0.001 | 0.004 | 0.898 | |
| Malpractice Insurance Expenses | MALPRAC | 0.000 | 0.000 | 0.007 | *** |
| Manpower Productivity | MANPROD | 0.006 | 0.002 | 0.01 | *** |
| Equation #4 | | **Operating Margin** | | | |
| | INTERCEP | -7.853 | 6.285 | 0.212 | |
| **Hospital Action** | ACTION | -408.602 | 168.546 | 0.016 | *** |
| **Monitoring** | MON32 | 488.412 | 286.994 | 0.089 | ** |
| **FP*Monitoring** | FPMON23 | -122.333 | 287.797 | 0.671 | |
| **FP * Hospital Action** | FPACT | 203.666 | 73.212 | 0.006 | *** |
| **HMO Percentage** | HMOPER2 | -13.655 | 9.655 | 0.158 | * |
| **HMO % * Action** | HMOACT | 857.087 | 724.464 | 0.237 | |
| FP Dummy | FP | -4.186 | 3.996 | 0.295 | |
| System Dummy | SYSTEM | 4.397 | 1.312 | 0.001 | *** |
| Beds size 100 - 300 | BED100 | 2.312 | 1.993 | 0.246 | |
| Beds size > 300 | BED300 | -0.076 | 2.700 | 0.978 | |
| Market HHI | HHI | 5.996 | 3.295 | 0.069 | * |
| Hospital Medicare % | MCRPER | 11.856 | 7.110 | 0.096 | * |
| Hospital Medicaid % | MCDPER | 2.425 | 8.951 | 0.787 | |
| Hospital expense / bed | EXPBED | 0.000 | 0.000 | 0.097 | * |

Single tailed tests (**in bold**), two tailed tests for control variables. * Sig. at .10 level, ** Sig at .05 level, *** Sig at .01 level

Figure 5.9 Purchase of Fixed Equip.



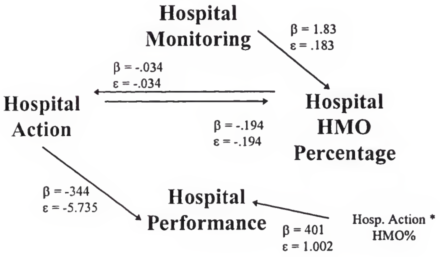
## Table 5.13 / Simultaneous Regression System 8:

Equation #1 **Purchase of Moveable Equip.**

| **System Weighted R-Squared .610** | | **Beta** | **S.E.** | **Sig.** | |
|---|---|---|---|---|---|
| | INTERCEP | 0.129 | 0.159 | 0.416 | |
| Lagged Dependent Variable | LACTION | 0.393 | 0.034 | 0.000 | *** |
| **Lagged HMO Percentage** | LHMOPER2 | -0.034 | 0.023 | 0.144 | * |
| **FP * Lagged HMO Percentage** | LFPHMOPE | 0.009 | 0.028 | 0.765 | |
| Lagged Operating Margin | LOPMARG | -0.001 | 0.000 | 0.000 | *** |
| **Monitoring** | MON32 | 0.472 | 1.210 | 0.696 | |
| **FP*Monitoring** | FPMON23 | -0.444 | 1.215 | 0.715 | |
| FP Dummy | FP | 0.009 | 0.016 | 0.565 | |
| System Dummy | SYSTEM | -0.001 | 0.006 | 0.842 | |
| Beds size 100 - 300 | BED100 | 0.006 | 0.008 | 0.405 | |
| Beds size > 300 | BED300 | 0.003 | 0.010 | 0.789 | |
| Market HHI | HHI | 0.013 | 0.013 | 0.320 | |
| MHS Share of Market | MHSHARE | 0.002 | 0.010 | 0.870 | |
| FP Share of Market | FPSHARE | -0.003 | 0.011 | 0.766 | |
| Median Income | INCOME | 0.000 | 0.000 | 0.967 | |
| Median Years of Education | EDUCAT | -0.008 | 0.013 | 0.532 | |
| Equation #2 | | **HMO Percentage** | | | |
| | INTERCEP | 0.031 | 0.017 | 0.067 | * |
| **Lagged Hospital Action** | LACTION | -0.194 | 0.094 | 0.040 | ** |
| **FP * Lagged Hospital Action** | LFPACT | 0.235 | 0.104 | 0.025 | ** |
| **Monitoring** | MON32 | 1.834 | 0.633 | 0.004 | *** |
| **FP*Monitoring** | FPMON23 | -0.519 | 0.570 | 0.364 | |
| Lagged Dependent Variable | LHMOPER2 | 0.848 | 0.021 | 0.000 | *** |
| System Dummy | SYSTEM | 0.000 | 0.006 | 0.970 | |
| Lagged Occupancy Rate | LOCCRT | -0.023 | 0.021 | 0.273 | |
| Market HHI | HHI | -0.016 | 0.019 | 0.410 | |
| HMO % in Market | MAPER | 0.152 | 0.039 | 0.000 | *** |
| Hosptial Medicaid % | MCDPER | -0.127 | 0.038 | 0.001 | *** |
| Population density 1980 | DENSITY | -0.000 | 0.000 | 0.401 | |
| Equation #3 | | **Monitoring** | | | |
| | INTERCEP | -0.001 | 0.006 | 0.917 | |
| **Action** | ACTION | 0.012 | 0.010 | 0.267 | |
| **Hospital HMO percentage** | HMOPER2 | 0.005 | 0.005 | 0.388 | |
| Hospital Wage | W4 | -0.000 | 0.000 | 0.004 | *** |
| FP Dummy | FP | 0.005 | 0.001 | 0.000 | *** |
| Beds size 100 - 300 | BED100 | 0.002 | 0.002 | 0.212 | |
| Beds size > 300 | BED300 | 0.007 | 0.002 | 0.001 | *** |
| Hospital Ambulatory Percentage | AMBPER | -0.002 | 0.018 | 0.922 | |
| Hospital Outpatient Percentage | OUTPER | 0.003 | 0.008 | 0.693 | |
| Median Income of Market | INCOME | 0.000 | 0.000 | 0.887 | |
| Medicare Percentage | MCRPER | 0.002 | 0.005 | 0.714 | |
| Occupancy Rate | OCCRT | -0.002 | 0.004 | 0.695 | |
| Malpractice Insurance Expenses | MALPRAC | 0.000 | 0.000 | 0.004 | *** |
| Manpower Productivity | MANPROD | 0.006 | 0.002 | 0.000 | *** |
| Equation #4 | | **Operating Margin** | | | |
| | INTERCEP | 2.525 | 7.737 | 0.744 | |
| **Hospital Action** | ACTION | -344.094 | 113.422 | 0.003 | *** |
| **Monitoring** | MON32 | 29.242 | 332.817 | 0.930 | |
| **FP*Monitoring** | FPMON23 | 214.224 | 333.042 | 0.520 | |
| **FP * Hospital Action** | FPACT | 210.127 | 87.655 | 0.017 | ** |
| **HMO Percentage** | HMOPER2 | -12.569 | 10.098 | 0.214 | |
| **HMO % * Action** | HMOACT | 400.781 | 194.595 | 0.040 | ** |
| FP Dummy | FP | -15.298 | 7.851 | 0.052 | ** |
| System Dummy | SYSTEM | 4.741 | 1.515 | 0.002 | *** |
| Beds size 100 - 300 | BED100 | 6.127 | 2.372 | 0.010 | *** |
| Beds size > 300 | BED300 | 3.411 | 2.793 | 0.222 | |
| Market HHI | HHI | 6.000 | 3.653 | 0.101 | * |
| Hospital Medicare % | MCRPER | 16.651 | 8.442 | 0.049 | ** |
| Hospital Medicaid % | MCDPER | 7.915 | 10.611 | 0.456 | |
| Hospital expense / bed | EXPBED | 0.000 | 0.000 | 0.297 | |

Single tailed tests (**in bold**), two tailed tests for control variables. * Sig. at .10 level, ** Sig at .05 level, *** Sig at .01 level

Figure 5.8 Purchase of Moveable Equip

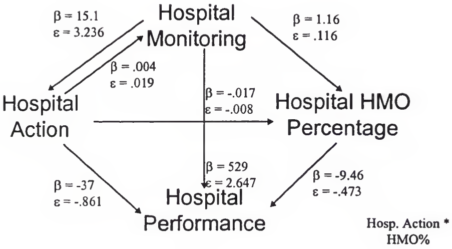


## Table 5.14 / Simultaneous Regression System 9:

| | Equation #1 | % Capital Retired | | | |
|---|---|---|---|---|---|
| **System Weighted R-Squared** | **.614** | **Beta** | **S.E.** | **Sig.** | |
| | INTERCEP | 1.118 | 1.211 | 0.356 | |
| Lagged Dependent Variable | LACTION | -0.002 | 0.007 | 0.799 | |
| **Lagged HMO Percentage** | LHMOPER2 | 0.054 | 0.176 | 0.760 | |
| **FP * Lagged HMO Percentage** | LFPHMOPE | -0.212 | 0.216 | 0.327 | |
| Lagged Operating Margin | LOPMARG | -0.012 | 0.001 | 0.000 | *** |
| **Monitoring** | MON32 | 15.102 | 9.409 | 0.109 | * |
| **FP*Monitoring** | FPMON23 | -9.635 | 9.442 | 0.308 | |
| FP Dummy | FP | 0.163 | 0.125 | 0.193 | |
| System Dummy | SYSTEM | -0.045 | 0.048 | 0.346 | |
| Beds size 100 - 300 | BED100 | 0.028 | 0.061 | 0.648 | |
| Beds size > 300 | BED300 | -0.076 | 0.079 | 0.338 | |
| Market HHI | HHI | 0.226 | 0.104 | 0.030 | ** |
| MHS Share of Market | MHSHARE | 0.021 | 0.077 | 0.784 | |
| FP Share of Market | FPSHARE | -0.095 | 0.081 | 0.244 | |
| Median Income | INCOME | 0.000 | 0.000 | 0.209 | |
| Median Years of Education | EDUCAT | -0.104 | 0.101 | 0.301 | |
| | Equation #2 | **HMO Percentage** | | | |
| | INTERCEP | 0.031 | 0.017 | 0.060 | * |
| **Lagged Hospital Action** | LACTION | -0.017 | 0.013 | 0.203 | * |
| **FP * Lagged Hospital Action** | LFPACT | 0.018 | 0.013 | 0.168 | * |
| **Monitoring** | MON32 | 1.159 | 0.570 | 0.042 | ** |
| **FP*Monitoring** | FPMON23 | 0.101 | 0.474 | 0.832 | |
| Lagged Dependent Variable | LHMOPER2 | 0.854 | 0.021 | 0.000 | *** |
| System Dummy | SYSTEM | 0.002 | 0.006 | 0.806 | |
| Lagged Occupancy Rate | LOCCRT | -0.025 | 0.021 | 0.227 | |
| Market HHI | HHI | -0.018 | 0.019 | 0.355 | |
| HMO % in Market | MAPER | 0.152 | 0.039 | 0.000 | *** |
| Hosptial Medicaid % | MCDPER | -0.117 | 0.038 | 0.003 | *** |
| Population density 1980 | DENSITY | -0.000 | 0.000 | 0.525 | |
| | Equation #3 | **Monitoring** | | | |
| | INTERCEP | -0.002 | 0.006 | 0.784 | |
| **Action** | ACTION | 0.004 | 0.001 | 0.005 | *** |
| **Hospital HMO percentage** | HMOPER2 | 0.005 | 0.006 | 0.353 | |
| Hospital Wage | W4 | -0.000 | 0.000 | 0.004 | *** |
| FP Dummy | FP | 0.006 | 0.001 | 0.000 | *** |
| Beds size 100 - 300 | BED100 | 0.002 | 0.002 | 0.244 | |
| Beds size > 300 | BED300 | 0.007 | 0.002 | 0.000 | *** |
| Hospital Ambulatory Percentage | AMBPER | -0.004 | 0.018 | 0.834 | |
| Hospital Outpatient Percentage | OUTPER | 0.003 | 0.007 | 0.648 | |
| Median Income of Market | INCOME | 0.000 | 0.000 | 0.988 | |
| Medicare Percentage | MCRPER | 0.004 | 0.005 | 0.443 | |
| Occupancy Rate | OCCRT | -0.001 | 0.004 | 0.841 | |
| Malpractice Insurance Expenses | MALPRAC | 0.000 | 0.000 | 0.006 | *** |
| Manpower Productivity | MANPROD | 0.006 | 0.002 | 0.000 | *** |
| | Equation #4 | **Operating Margin** | | | |
| | INTERCEP | -9.926 | 6.662 | 0.137 | |
| **Hospital Action** | ACTION | -36.894 | 25.476 | 0.148 | * |
| **Monitoring** | MON32 | 529.352 | 328.322 | 0.107 | * |
| **FP*Monitoring** | FPMON23 | -207.999 | 329.177 | 0.528 | |
| **FP * Hospital Action** | FPACT | 15.774 | 19.415 | 0.417 | |
| **HMO Percentage** | HMOPER2 | -9.461 | 9.503 | 0.320 | |
| **HMO % * Action** | HMOACT | 40.943 | 66.781 | 0.540 | |
| FP Dummy | FP | 0.362 | 4.446 | 0.935 | |
| System Dummy | SYSTEM | 2.781 | 1.554 | 0.074 | * |
| Beds size 100 - 300 | BED100 | 4.401 | 2.482 | 0.077 | * |
| Beds size > 300 | BED300 | 1.687 | 2.837 | 0.552 | |
| Market HHI | HHI | 7.507 | 3.763 | 0.047 | ** |
| Hospital Medicare % | MCRPER | 7.395 | 7.487 | 0.324 | |
| Hospital Medicaid % | MCDPER | 2.082 | 10.088 | 0.837 | |
| Hospital expense / bed | EXPBED | 0.000 | 0.000 | 0.415 | |

Single tailed tests (in bold), two tailed tests for control variables. * Sig. at .10 level, ** Sig at .05 level, *** Sig at .01 level

Figure 5.9 % Capital Retired

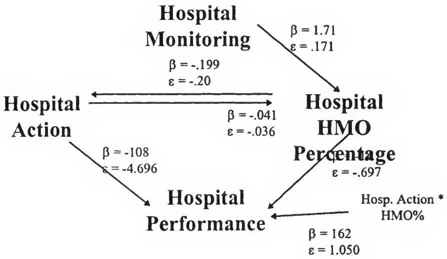


# Table 5.15 / Simultaneous Regression System 10:

| Equation #1 | % Capital Added | | | | |
|---|---|---|---|---|---|
| **System Weighted R-Squared .610** | | **Beta** | **S.E.** | **Sig.** | |
| | INTERCEP | 0.533 | 0.510 | 0.296 | |
| Lagged Dependent Variable | LACTION | 0.193 | 0.027 | 0.000 | *** |
| **Lagged HMO Percentage** | LHMOPER2 | -0.199 | 0.075 | 0.008 | *** |
| **FP * Lagged HMO Percentage** | LFPHMOPE | 0.159 | 0.091 | 0.082 | * |
| Lagged Operating Margin | LOPMARG | -0.005 | 0.001 | 0.000 | *** |
| **Monitoring** | MON32 | 4.749 | 3.978 | 0.233 | |
| **FP*Monitoring** | FPMON23 | -4.255 | 3.992 | 0.287 | |
| FP Dummy | FP | 0.032 | 0.053 | 0.540 | |
| System Dummy | SYSTEM | -0.010 | 0.020 | 0.614 | |
| Beds size 100 - 300 | BED100 | 0.000 | 0.025 | 0.992 | |
| Beds size > 300 | BED300 | -0.015 | 0.033 | 0.641 | |
| Market HHI | HHI | 0.024 | 0.044 | 0.586 | |
| MHS Share of Market | MHSHARE | -0.010 | 0.033 | 0.752 | |
| FP Share of Market | FPSHARE | -0.035 | 0.035 | 0.322 | |
| Median Income | INCOME | 0.000 | 0.000 | 0.390 | |
| Median Years of Education | EDUCAT | -0.035 | 0.042 | 0.406 | |
| Equation #2 | | **HMO Percentage** | | | |
| | INTERCEP | 0.025 | 0.017 | 0.127 | |
| **Lagged Hospital Action** | LACTION | -0.041 | 0.027 | 0.129 | * |
| **FP * Lagged Hospital Action** | LFPACT | 0.061 | 0.030 | 0.040 | ** |
| **Monitoring** | MON32 | 1.710 | 0.611 | 0.005 | *** |
| **FP*Monitoring** | FPMON23 | -0.310 | 0.529 | 0.558 | |
| Lagged Dependent Variable | LHMOPER2 | 0.850 | 0.021 | 0.000 | *** |
| System Dummy | SYSTEM | 0.000 | 0.006 | 0.949 | |
| Lagged Occupancy Rate | LOCCRT | -0.019 | 0.021 | 0.356 | |
| Market HHI | HHI | -0.016 | 0.019 | 0.406 | |
| HMO % in Market | MAPER | 0.153 | 0.039 | 0.000 | *** |
| Hosptial Medicaid % | MCDPER | -0.121 | 0.038 | 0.002 | *** |
| Population density 1980 | DENSITY | -0.000 | 0.000 | 0.515 | |
| Equation #3 | | **Monitoring** | | | |
| | INTERCEP | -0.000 | 0.006 | 0.947 | |
| **Action** | ACTION | 0.000 | 0.004 | 0.920 | |
| **Hospital HMO percentage** | HMOPER2 | 0.005 | 0.006 | 0.366 | |
| Hospital Wage | W4 | -0.000 | 0.000 | 0.004 | *** |
| FP Dummy | FP | 0.005 | 0.001 | 0.000 | *** |
| Beds size 100 - 300 | BED100 | 0.002 | 0.002 | 0.210 | |
| Beds size > 300 | BED300 | 0.007 | 0.002 | 0.001 | *** |
| Hospital Ambulatory Percentage | AMBPER | -0.001 | 0.018 | 0.938 | |
| Hospital Outpatient Percentage | OUTPER | 0.003 | 0.007 | 0.729 | |
| Median Income of Market | INCOME | 0.000 | 0.000 | 0.888 | |
| Medicare Percentage | MCRPER | 0.003 | 0.005 | 0.614 | |
| Occupancy Rate | OCCRT | -0.001 | 0.004 | 0.791 | |
| Malpractice Insurance Expenses | MALPRAC | 0.000 | 0.000 | 0.004 | *** |
| Manpower Productivity | MANPROD | 0.006 | 0.002 | 0.0002 | *** |
| Equation #4 | | **Operating Margin** | | | |
| | INTERCEP | -2.555 | 6.173 | 0.679 | |
| **Hospital Action** | ACTION | -108.363 | 27.341 | 0.000 | *** |
| **Monitoring** | MON32 | 155.248 | 284.373 | 0.585 | |
| **FP*Monitoring** | FPMON23 | 61.269 | 283.575 | 0.829 | |
| **FP * Hospital Action** | FPACT | 51.815 | 19.340 | 0.008 | *** |
| **HMO Percentage** | HMOPER2 | -13.971 | 8.957 | 0.119 | * |
| **HMO % * Action** | HMOACT | 161.610 | 58.746 | 0.006 | *** |
| FP Dummy | FP | -10.837 | 5.513 | 0.050 | ** |
| System Dummy | SYSTEM | 3.622 | 1.297 | 0.005 | *** |
| Beds size 100 - 300 | BED100 | 6.000 | 2.055 | 0.004 | *** |
| Beds size > 300 | BED300 | 3.388 | 2.445 | 0.166 | |
| Market HHI | HHI | 4.615 | 3.165 | 0.145 | |
| Hospital Medicare % | MCRPER | 20.090 | 7.310 | 0.006 | *** |
| Hospital Medicaid % | MCDPER | 13.367 | 9.428 | 0.157 | |
| Hospital expense / bed | EXPBED | 0.000 | 0.000 | 0.089 | * |

Single tailed tests (**in bold**), two tailed tests for control variables. * Sig. at .10 level, ** Sig at .05 level, *** Sig at .01 level

Figure 5.10 % Capital Added



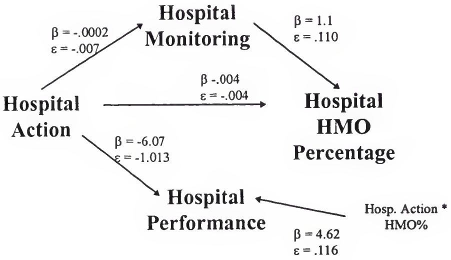
## Table 5.16 / Simultaneous Regression System 11:

Equation #1 **Ratio Capital Retired / Added**

| **System Weighted R-Squared** | **.617** | **Beta** | **S.E.** | **Sig.** | |
|---|---|---|---|---|---|
| | INTERCEP | 3.092 | 13.968 | 0.825 | |
| Lagged Dependent Variable | LACTION | -0.047 | 0.038 | 0.221 | |
| **Lagged HMO Percentage** | LHMOPER2 | 1.084 | 1.987 | 0.586 | |
| **FP * Lagged HMO Percentage** | LFPHMOPE | -1.037 | 2.427 | 0.669 | |
| Lagged Operating Margin | LOPMARG | -0.186 | 0.017 | 0.000 | *** |
| **Monitoring** | MON32 | -62.983 | 103.805 | 0.544 | |
| **FP*Monitoring** | FPMON23 | 26.964 | 104.215 | 0.796 | |
| FP Dummy | FP | 0.142 | 1.391 | 0.919 | |
| System Dummy | SYSTEM | 0.824 | 0.529 | 0.119 | |
| Beds size 100 - 300 | BED100 | 0.489 | 0.674 | 0.468 | |
| Beds size > 300 | BED300 | 0.811 | 0.865 | 0.349 | |
| Market HHI | HHI | 0.728 | 1.143 | 0.525 | |
| MHS Share of Market | MHSHARE | 0.559 | 0.872 | 0.522 | |
| FP Share of Market | FPSHARE | 0.628 | 0.941 | 0.505 | |
| Median Income | INCOME | 0.000 | 0.000 | 0.338 | |
| Median Years of Education | EDUCAT | -0.291 | 1.164 | 0.803 | |
| Equation #2 | | **HMO Percentage** | | | |
| | INTERCEP | 0.038 | 0.017 | 0.024 | ** |
| **Lagged Hospital Action** | LACTION | -0.004 | 0.001 | 0.004 | *** |
| **FP * Lagged Hospital Action** | LFPACT | 0.001 | 0.002 | 0.646 | |
| **Monitoring** | MON32 | 1.098 | 0.568 | 0.054 | ** |
| **FP*Monitoring** | FPMON23 | 0.111 | 0.474 | 0.815 | |
| Lagged Dependent Variable | LHMOPER2 | 0.860 | 0.021 | 0.000 | *** |
| System Dummy | SYSTEM | 0.001 | 0.006 | 0.830 | |
| Lagged Occupancy Rate | LOCCRT | -0.033 | 0.021 | 0.118 | |
| Market HHI | HHI | -0.019 | 0.020 | 0.345 | |
| HMO % in Market | MAPER | 0.147 | 0.039 | 0.000 | *** |
| Hosplial Medicaid % | MCDPER | -0.120 | 0.039 | 0.002 | *** |
| Population density 1980 | DENSITY | -0.000 | 0.000 | 0.541 | |
| Equation #3 | | **Monitoring** | | | |
| | INTERCEP | 0.001 | 0.006 | 0.810 | |
| **Action** | ACTION | -0.000 | 0.000 | 0.002 | *** |
| **Hospital HMO percentage** | HMOPER2 | 0.005 | 0.006 | 0.404 | |
| Hospital Wage | W4 | -0.000 | 0.000 | 0.002 | *** |
| FP Dummy | FP | 0.005 | 0.001 | 0.000 | *** |
| Beds size 100 - 300 | BED100 | 0.002 | 0.002 | 0.293 | |
| Beds size > 300 | BED300 | 0.007 | 0.002 | 0.001 | *** |
| Hospital Ambulatory Percentage | AMBPER | -0.002 | 0.018 | 0.929 | |
| Hospital Outpatient Percentage | OUTPER | 0.001 | 0.007 | 0.866 | |
| Median Income of Market | INCOME | 0.000 | 0.000 | 0.834 | |
| Medicare Percentage | MCRPER | 0.002 | 0.005 | 0.629 | |
| Occupancy Rate | OCCRT | -0.003 | 0.004 | 0.506 | |
| Malpractice Insurance Expenses | MALPRAC | 0.000 | 0.000 | 0.005 | *** |
| Manpower Productivity | MANPROD | 0.006 | 0.002 | 0.0001 | *** |
| Equation #4 | | **Operating Margin** | | | |
| | INTERCEP | -5.108 | 6.829 | 0.455 | |
| **Hospital Action** | ACTION | -6.079 | 3.599 | 0.092 | ** |
| **Monitoring** | MON32 | 375.375 | 308.692 | 0.225 | |
| **FP*Monitoring** | FPMON23 | -44.675 | 310.374 | 0.886 | |
| **FP * Hospital Action** | FPACT | 3.014 | 2.265 | 0.184 | * |
| **HMO Percentage** | HMOPER2 | -7.872 | 8.638 | 0.363 | |
| **HMO % * Action** | HMOACT | 4.620 | 3.612 | 0.201 | * |
| FP Dummy | FP | -2.302 | 3.874 | 0.553 | |
| System Dummy | SYSTEM | 3.431 | 1.590 | 0.031 | ** |
| Beds size 100 - 300 | BED100 | 1.446 | 2.035 | 0.478 | |
| Beds size > 300 | BED300 | -0.396 | 3.225 | 0.902 | |
| Market HHI | HHI | 3.843 | 3.346 | 0.251 | |
| Hospital Medicare % | MCRPER | 9.068 | 6.894 | 0.189 | |
| Hospital Medicaid % | MCDPER | 2.785 | 9.544 | 0.771 | |
| Hospital expense / bed | EXPBED | 0.000 | 0.000 | 0.655 | |

Single tailed tests (**in bold**), two tailed tests for control variables. * Sig. at .10 level, ** Sig at .05 level, *** Sig at .01 level

Figure 5.11 Ratio Capital Retired / Added



## Table 5.17: Hypothesized Signs on Study Variables

| General Hypothesis | **Equation #1: Hospital Action** | % Beds Subacute | % Beds Acute | % Beds Intensive Care | Total Licensed Beds | Total FTEs | Ambulatory Staff FTEs | Purch. Fixed Equiptment | Purch. Moveable Equipt. | % Capital Retired | % Capital Added | Ratio: Reitred / Added |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **H.A.1** | HMO % | + | - | - | - | - | + | - | - | + | - | + |
| **H.A.2** | FP*HMO% | - | + | + | + | + | - | + | + | - | + | - |
| **H.B.1** | Monitoring | - | + | + | + | + | + | + | + | - | + | - |
| **H.B.2** | FP*Monitoring | + | - | - | - | - | + | - | - | + | - | + |
| | **HMO %** | | | | | | | | | | | |
| **H.C.1** | Action | + | - | - | - | - | + | - | - | + | - | + |
| **H.C.2** | FP*Action | - | + | + | + | + | - | + | + | - | + | - |
| **H.D.1** | Monitoring | + | + | + | + | + | + | + | + | + | + | + |
| **H.D.2** | FP*Monitoring | - | - | - | - | - | - | - | - | - | - | - |
| | **Monitoring** | | | | | | | | | | | |
| **H.F** | Action | - | - | + | + | + | - | + | + | - | + | - |
| **H.E** | HMO % | + | + | + | + | + | + | + | + | + | + | + |
| | **Performance** | | | | | | | | | | | |
| **H.G.1** | Action | - | - | - | - | - | - | - | - | - | - | - |
| **H.H** | Monitoring | + | + | + | + | + | + | + | + | + | + | + |
| | FP*Monitoring | + | + | + | + | + | + | + | + | + | + | + |
| | FP * Action | + | + | + | + | + | + | + | + | + | + | + |
| **H.I** | HMO % | - | - | - | - | - | - | - | - | - | - | - |
| **H.G.2** | HMO * Action | + | + | + | + | + | + | + | + | + | + | + |

## Table 5.18: Result Signs on Study Variables

| **Equation #1: Hospital Action** | % Beds Subacute | % Beds Acute | % Beds Intensive Care | Total Licensed Beds | Total FTEs | Ambulatory Staff FTEs | Purch. Fixed Equiptment | Purch. Moveable Equipt. | % Capital Retired | % Capital Added | Ratio: Reitred / Added |
|---|---|---|---|---|---|---|---|---|---|---|---|
| HMO % | - | + | - | + | - | + | - | - | + | - | + |
| FP*HMO% | - | + | - | - | + | - | + | + | - | + | - |
| Monitoring | - | - | + | - | + | + | + | + | + | + | - |
| FP*Monitoring | - | + | - | + | - | - | - | - | - | - | + |
| **Eq #2 - HMO %** | | | | | | | | | | | |
| Action | - | - | - | + | + | + | - | - | - | - | - |
| FP*Action | + | + | + | + | + | + | + | + | + | + | + |
| Monitoring | + | + | + | + | + | + | + | + | + | + | + |
| FP*Monitoring | + | - | - | - | + | - | + | - | + | - | + |
| **Eq #3 - Monitoring** | | | | | | | | | | | |
| Action | - | - | + | + | + | + | + | + | + | + | - |
| HMO % | + | + | + | + | + | + | + | + | + | + | + |
| **Eq #4 - Performance** | | | | | | | | | | | |
| Action | - | - | + | - | - | - | - | - | - | - | - |
| Monitoring | + | - | - | + | - | + | + | + | + | + | + |
| FP*Monitoring | - | + | + | + | + | + | - | + | - | + | - |
| FP * Action | + | + | - | + | + | + | + | + | + | + | + |
| HMO % | - | + | + | - | - | - | - | - | - | - | - |
| HMO % * Action | + | - | - | + | + | + | + | + | + | + | + |

Shaded cells indicate significant result in a one-tailed test

## Table 5.19: Confirmation of Study Hypotheses

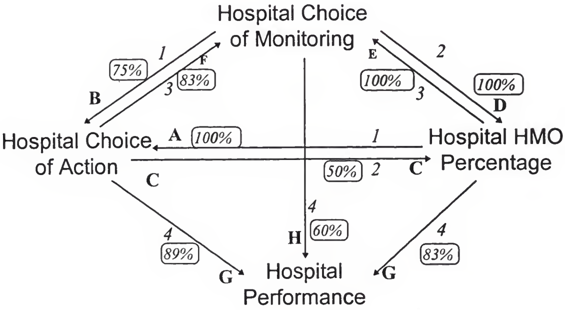
| **Equation #1: Hospital Action** | % Beds Subacute | % Beds Acute | % Beds Intensive Care | Total Licensed Beds | Total FTEs | Ambulatory Staff FTEs | Purch. Fixed Equiptment | Purch. Moveable Equipt. | % Capital Retired | % Capital Added | Ratio: Reitred / Added | Signif. Results Supported | Signif. NOT Supported | % Significant Hypoth Supp. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HMO % | N | N | Y | N | Y | Y | Y | Y | Y | Y | Y | **4** | **0** | **100%** |
| FP*HMO% | Y | Y | N | N | Y | Y | Y | Y | Y | Y | Y | **2** | **0** | **100%** |
| Monitoring | Y | N | Y | N | Y | Y | Y | Y | N | Y | Y | **3** | **1** | **75%** |
| FP*Monitoring | N | N | Y | N | Y | Y | Y | Y | N | Y | Y | **1** | **0** | **100%** |
| **Eq #2 - HMO %** | | | | | | | | | | | | | | |
| Action | N | Y | Y | N | N | Y | Y | Y | N | Y | N | **4** | **4** | **50%** |
| FP*Action | N | Y | Y | Y | Y | N | Y | Y | N | Y | N | **6** | **1** | **86%** |
| Monitoring | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | **10** | **0** | **100%** |
| FP*Monitoring | N | Y | Y | Y | N | Y | N | Y | N | Y | N | **2** | **0** | **100%** |
| **Eq #3 - Monitoring** | | | | | | | | | | | | | | |
| Action | Y | Y | Y | Y | Y | Y | Y | Y | N | Y | Y | **5** | **1** | **83%** |
| HMO % | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | **1** | **0** | **100%** |
| **Eq #4 - Performance** | | | | | | | | | | | | | | |
| Action | Y | Y | N | Y | Y | Y | Y | Y | Y | Y | Y | **8** | **1** | **89%** |
| Monitoring | Y | N | N | Y | N | Y | Y | Y | Y | Y | Y | **3** | **2** | **60%** |
| FP*Monitoring | N | Y | Y | Y | Y | Y | N | Y | N | Y | N | **2** | **0** | **100%** |
| FP * Action | Y | Y | N | Y | Y | Y | Y | Y | Y | Y | Y | **9** | **1** | **90%** |
| HMO % | Y | N | N | Y | Y | Y | Y | Y | Y | Y | Y | **5** | **1** | **83%** |
| HMO % * Action | Y | N | N | Y | Y | Y | Y | Y | Y | Y | Y | **8** | **1** | **89%** |

Y = hypothesis supported, N = hypothesis not supported
Shaded cells indicate significant result in a one-tailed test

## Table 5.20: Signs on Control Variables

| **Equation #1: Hospital Action** | % Beds Subacute | % Beds Acute | % ICU Beds | Total Lic. Beds | Total FTEs | Amb. Staff FTEs | Purch. Fixed Equipt. | Purch. Move. Equipt. | % Capital Retired | % Capital Added | Reitred / Added |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lagged Dep. | .92 | .61 | .94 | .99 | 1.0 | .88 |  | .40 |  | .19 |  |
| Operating Margin | + | - | + | + | + | - | - | - | - | - | - |
| FP Dummy | + | - | + | + | - | - | - | + | + | + | + |
| System Dummy | + | - | - | - | + | - | + | - | - | - | + |
| Bed Size 100-300 | - | - | - | - | + | + | - | + | + | + | + |
| Bed Size > 300 | + | - | - | + | + | + | - | + | - | - | + |
| Market HHI | - | + | + | - | - | + | + | + | + | + | + |
| MHS Share | + | + | - | - | - | + | - | + | + | - | + |
| FP Share | + | - | + | - | - | - | + | - | - | - | + |
| Median Income | - | - | + | + | - | - | + | + | + | + | + |
| Median Education | + | - | + | - | + | + | - | - | - | - | - |
| **Eq #2: HMO %** |  |  |  |  |  |  |  |  |  |  |  |
| Lagged Dep | .76 | .86 | .82 | .84 | .84 | .85 | .85 | .85 | .85 | .85 | .86 |
| System | - | + | - | + | + | + | + | + | + | + | + |
| Lagged Occ. Rate | - | - | - | - | - | - | - | - | - | - | - |
| Market HHI | - | - | - | - | - | - | - | - | - | - | - |
| Market HMO % | + | + | + | + | + | + | + | + | + | + | + |
| Medicaid % | - | - | - | - | - | - | - | - | - | - | - |
| Pop. Density 1980 | - | - | - | - | - | - | - | - | - | - | - |
| **Eq #3: Monitoring** |  |  |  |  |  |  |  |  |  |  |  |
| Hospital Wage | - | - | - | - | - | - | - | - | - | - | - |
| FP Dummy | + | + | + | + | + | + | + | + | + | + | + |
| Bed Size 100-300 | + | + | + | + | + | + | + | + | + | + | + |
| Bed Size > 300 | + | + | + | + | + | + | + | + | + | + | + |
| Ambulatory % | + | - | - | - | - | - | - | - | - | - | - |
| Outpatient % | + | + | + | + | + | + | + | + | + | + | + |
| Median Income | - | - | - | + | + | + | + | + | + | + | + |
| Medicare % | + | + | - | + | + | + | + | + | + | + | + |
| Occupancy Rate | - | + | - | - | - | - | - | - | - | - | - |
| Malpractice Ins. Exp | + | + | + | + | + | + | + | + | + | + | + |
| Manpower Prod. | + | + | + | + | + | + | + | + | + | + | + |
| **Eq #4: Performance** |  |  |  |  |  |  |  |  |  |  |  |
| FP Dummy | - | - | + | - | - | - | - | - | + | - | - |
| System Dummy | + | + | + | + | + | + | + | + | + | + | + |
| Bed Size 100-300 | + | + | + | + | + | + | + | + | + | + | + |
| Bed Size > 300 | + | - | + | + | + | + | - | + | + | + | - |
| Market HHI | + | + | + | + | + | + | + | + | + | + | + |
| Medicare % | + | + | - | + | + | + | + | + | + | + | + |
| Medicaid % | - | + | - | - | - | + | + | + | + | + | + |
| Expense / Bed | + | + | + | + | + | + | + | + | + | + | + |

Figure 5.13: Summary of Supported Hypotheses



# Chapter 6: Discussion

## *Summary of Argument*

This thesis presents a theoretical framework for hospital response to managed care. In addition, the actions taken by hospitals are an attempt not only to configure themselves in such a way that they might effectively meet the new market demand, but also to control a very important agency problem. I argue that the conversion of traditionally insured fee-for-service (FFS) patients to managed care represents a segment of the hospital's demand that desires a lower level of inputs to be delivered[43]. The hospital, however, is operating at the minimum of a cost curve determined by the historically high demand of the fully insured FFS patient. It has chosen its level of capital and labor in such a way that it can produce a high level of service at minimum cost. If, however, a portion of it patient population now desires a lower level of care, it must reduce the level of services.

A simple reduction in the number of units delivered will increase the average cost, because there are fewer outputs to spread the fixed cost across. In addition, the presence of imperfect physician agency and a general lack of alignment between the objectives of the hospital (given it fee schedule) and the physician (given his or her fee schedule) results in physicians oversupplying hospital inputs. The hospital therefore must increase its level of monitoring or utilization review to constrain the delivery of inputs to these patients. This increases both the marginal and average cost for delivery of a lower level of care. The question for hospitals therefore is; what is the most cost effective means of reducing both the level of inputs delivered and the corresponding agency costs due to the mis-alignment of physician incentives?

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[43] This does not necessarily mean that these patients seek a lower level of care however. HMO patients may not, on the margin, value an additional hospital input in excess of cost. This could be due to either the fact that these individuals have a lower valuation of health in general, or they believe that the marginal valuation of the additional hospital input is not greater than the marginal cost they face, or depending on the structure of the HMO, that the marginal valuation of the additional inputs is not greater than zero.

The models in Chapter 3 suggest that the hospital may achieve these reductions either by explicitly rationing the available resources to the physician or by increasing its monitoring . Appropriate reductions in capacity and increases in the level of monitoring may have an effect on overall performance in the face of increasing managed care penetration. At the same time, however, the hospital must trade off its adjustment of its production function with the effect this will have on the demand from existing FFS patients. To the extent that production of cost-effective managed care hospitalization is inconsistent with cost-effective FFS hospitalization, the hospital will be faced with difficult tradeoffs. At the heart of this inquiry is the extent to which the hospital believes that in the future managed care will dominate the payer landscape and the speed with which this conversion will occur.

### *Implications of Empirical Results*

The empirical analyses supported a number of the hypotheses given in Chapter 4 and depicted in Figure 5.13. In particular, there is some evidence that HMOs lead hospitals to reduce their level of resource-intensive services or capacity. However, the difference between for-profit and non-profit hospitals does not appear to be significant[44]. Monitoring appears to substitute for the retirement of capital while increases in monitoring allow for complementary increases in hospital actions that increase resources or capacity. In addition, monitoring has a consistently positive effect on HMO demand, suggesting that having monitoring in place may be a precursor to taking on HMO contracts. HMO penetration, on the other hand, does not appear to increase the level of monitoring significantly. There is some weak evidence supporting the hypothesis that appropriate hospital action (actions which reduce the available capacity) are met with increases in HMO demand. Actions by for-profit hospitals consistently appear to affect the percentage of HMO patients. Finally, hospital action decreases performance overall while increasing performance for HMO patients. HMO penetration has a consistently negative impact on performance.

In general HMO% and monitoring do not appear to have a consistent effects on hospital action, though hospital action and monitoring do appear to have a consistent effect on HMO% as predicted. This suggests that, while HMO% is not consistently driving observed hospital behavior, hospitals that do take action in anticipation of increasing HMO share will be rewarded with increased HMO demand. Hospital action and monitoring appear to be complementary in their effects, as evidenced by the significant positive coefficients on hospital action in the monitoring equation for services that increase resource availability or capacity. In addition, while the effect of HMO% on the level of monitoring is positive in all eleven models it is significant in only one model. This implies that, while monitoring is a necessary precursor to taking on HMO patients, HMO% does not have a consistently significant effect on the level of hospital monitoring. This system of results shows the importance of monitoring and action influencing performance and HMO%.

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[44] Manning found similar results in his 1973 analysis. The "insignificant differences in legal status (after insurance and staff size are allowed for) suggests that the direct cost effects of legal differences are minor compared to other institutional characteristics."

### *General Implications*

From the empirical results as well as the theoretical model some more general implications may be drawn with respect to hospital behavior as well the structure of hospital markets more generally.

**The market will drive managed care firms to concentrate their admissions in select hospitals.**

The theoretical model demonstrates that the hospital will have to adjust its level of capacity over time in response to increasing HMO penetration. Hospitals with more managed care are able to make a more complete adjustment to the new SRAC and therefore deliver services to the HMO at lower cost. At the same time, the amount of adjustment the hospital is likely to make is limited by the presence of indemnity patients who desire and pay for a higher level of service. For the hospital to make the shift in its production function it must have a sufficient population of HMO patients. Given a sufficient level of HMO demand the hospital will be more likely to change its production function to meet the demands of the HMO. In addition, once the hospital has adjusted its level of capacity it will be able to deliver care to HMO patients at lower cost. As a result increasing HMO penetration in a hospital may lead to lower prices due to increased efficiency rather than simply an exercise of market power. The HMO however, must weigh the benefits that come from contracting with a few hospitals which has a production functions styled to deliver a lower level of care with the benefits the HMO may receive from having a wide geographic coverage. There may be a return to FFS reimbursement over time.

The theoretical model develops an interesting though untested proposition. It shows that as a hospital's HMO percentage increases the HMO will increasingly reimburse the hospital in the form of the variable per unit payment (v), because by this time, the hospital has a large HMO population and has reconfigured its production system according to a lower level of demand for hospital inputs. The HMO will no longer need to use a fixed payment to beat back the FFS incentives in the hospital to deliver a high level of output. This result is sensitive to the structure of the game; the structure of the HMO reimbursement always follows the hospital's choice of capital investment.

The sequence of events is as follows: 1) the hospital starts with excess capacity; 2) the HMO writes a capitated contract with the hospital to drive out the excess capacity, though this takes time; 3) once the HMO has driven out all the excess capacity, it pays some discounted fee-for-service (v). For this to be stable (which remains to be proven), hospitals must be sufficiently sophisticated and know that if they increase the delivery of inputs beyond the HMO's desired level will be met with a decrease in the variable payment and increase in the fixed payment. Without this sophistication, it is possible that there would be a cycling between these methods of payment. In the long run this dynamic would lead to a discounted FFS payment by the HMO. This, interestingly enough, suggests that the HMO will return to a FFS type of reimbursement in this model. The fixed payment is a transitional payment only to drive down the hospital's level of capacity. The new variable payment (v) will be less than the old FFS price (p) paid but it will be similar in form.

**Increasing HMO penetration may increase cost to FFS insurers.**

When the hospital's HMO penetration reaches a sufficiently high level it will adjust its production function so that it is at the minimum of a short-run average cost curve (SRAC) for a population that desires a lower level of hospital inputs. If the hospital is operating at the minimum of this SRAC, any increase in the number of inputs demanded would result in an increase in price. To the extent that there remain any FFS patients in the market desiring a higher level of service, the prices they have to pay may be greater than in the absence of HMO penetration. Whether this is in fact the case is determined by the degree to which the SRAC is upward sloping past its minimum point. If the hospital is operating on a new SRAC reflecting the increased HMO penetration, and this curve has a flat bottom the price to be paid by the FFS insurers will not be that much greater than the price paid by the HMO. In addition this new price is likely to be less than what was paid by the FFS insurer in the absence of any HMO patients. This is unlikely to be the case however. If this was the case the hospital would likely already be at that point in an effort to deliver care to FFS patients at minimum cost.

An example may make this more clear. Assume that the hospital has reduced its staffing to the point where it has just enough nurses to meet the low demands of the HMO patients. An additional FFS patient arrives at the hospital requiring more nursing hours. To meet this need the hospital may have to add overtime staff. Inputs, in this case nurses, are fungible across patient types, but the cost of meeting the higher need of the fee-for-service patient requires a costly addition of capacity, thereby increasing the price the FFS insurer may have to pay for care[45].

### Physician integration may be an attempt to align physician incentives.

There has been increased interest in the topic of physician-hospital inter-organizational relationships over the past 5 years, mirroring the interest and activities seen in the practitioner community. Integration has been viewed for the most part as an unconditional good yet the theoretical justification for such a normative statement is often less than compelling. Claims such as increased efficiency and lower costs due to increased coordination are often offered as justification for increasing the degree of integration between physicians and hospitals. This thesis speaks more directly to the potential benefits from integration and when such benefits may exist.

There are efficiency gains to be had when there is an agency problem leading to an oversupply of hospital inputs to the HMO population. The magnitude of the agency costs is proportional to the difference in the objectives of the physician and the hospital. If, however, the structure of the physician's reimbursement is such that he or she does not have an incentive to over-supply free hospital inputs, the efficiency gains from integration would have to result from some other factor.

### An un-coordinated fee schedule may not be such a bad thing.

This thesis has argued for the presence of agency costs and further that a hospital's adjustment of it monitoring and capital endowments may be viewed as an attempt to economize on these agency costs. Paradoxically, it might be better to have an uncoordinated fee schedule in which a natural tension exists between physician and hospital objectives when quality is not easily measured than a coordinated fee schedule in which both the physician and the hospital have an incentive to under-provide quality. If hospitals are reimbursed on a completely capitated basis they will have an incentive to provide lower quality[46]. The lower bound on the quality delivered will be a function of the extent to which patients can assess this lower quality and vote with their feet. Lacking sound information on quality, the degree to which lower quality is delivered will not be disciplined by a market mechanism.

If physicians are compensated on a fee-for-service basis such that they have an incentive to deliver more services to the patient, and the delivery of these services is associated with a higher level of quality, the physician's fee schedule will result in a lower bound on quality. In fact, it may be possible for the HMO to tailor the level of

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[45] Interestingly enough if this is the case the price of FFS insurance will increase as more individuals select managed care plans, aside from the adverse selection argument. In addition to the remaining FFS patients being more

quality produced by the physician-hospital pair by varying the degree of capitation and fee-for-service reimbursement for each of the actors.

This is not meant to suggest, however, that this internal solution on the level of quality resulting from the tension between the physician and hospital fee schedules is more or less optimal than separate two-part reimbursement schedules[47] for the physician and the hospital separately. It remains to be seen whether such schedules, tailored to deliver the desired level of quality, are more optimal than separate fee schedules in which the physician on a FFS basis and the hospital is paid on a capitated basis.

## *Research Implications*

### Health Care

This thesis has a number of important implications and results for the health care literature. First, it develops a theoretical model to explain hospital's adjustment or response to managed care. It shows that hospitals will reduce their level of capacity in response to increasing managed care. This is intuitively obvious and is supported by the real world fact that over time we have seen hospital occupancy rates declining. It goes on to suggest that the relationship between the physician and the hospital is an important determinant of hospital action; the actions hospitals take may be viewed as an effort to control the agency problem between physicians and hospitals. The lack of coordination resulting from separate fee schedules increases the agency cost.

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acute and requiring a higher level of service, they will also now find themselves in hospitals which are not configured to deliver care at minimum cost. This will increase the costliness of FFS insurance.

The theoretical model in this thesis extends the results of Custer et al. (1990) and Rogerson (1994) in meaningful ways. Related to the former's exposition of how the quantity of care will fall with the introduction of PPS, this thesis illuminates the mechanism by which this change occurs. Starting from Rogerson's consideration of how a non-profit hospital selects treatment intensities, this thesis builds in a distinction between short run and long run costs as well as the observation that hospitals choose treatment intensities only indirectly through their choice of capacity and monitoring. This creates a cogent argument for hospital behavior in addition to showing and testing the mechanism by which these changes occur.

Taken jointly with the empirical results, this thesis puts forth one of the few economic models of hospital behavior identifies explicitly that the mechanism by which hospitals may adjust their organizations and further how this affects both subsequent HMO demand and financial performance. This information is of value. Knowing the equilibrium configuration is important, but that configuration of providers and organizations may be achieved in a number of ways. The ways in which hospitals respond to changes in their environment may fundamentally affect their ability to survive. The increasing presence of HMO penetration in the hospital suggests that the agency problem between hospitals and physicians may become more acute. This alone however delivers few prescriptions to managers as to the best way to ameliorate the agency problem. This thesis delivers managerial prescriptions by explicitly considering two such mechanisms, monitoring and capacity reduction.

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[46] To the extent that there is not significant and demonstrable quality competition in the market

## Broader Literature

This thesis extends the principal-agent literature by integrating the solution to the principal agent problem into a consideration of business strategy. In particular, it shows that the agency costs may influence the strategic actions taken by the firm. In addition, the theoretical model suggests that the presence of agency costs may lead to sub-optimal investment by the firm. In the absence of agency costs, the hospital would choose a level of capacity to meet the new demand. However, in the presence of agency costs the hospital may reduce the level of capacity beyond the optimal point to reduce the availability of these resources and control the agency problem.

### *Managerial Implications*

My work offers important results for managers of hospitals as well as managed care organizations. With respect to hospitals, this research suggests that changing their organizations is likely to reduce their performance for their existing FFS patients. The manager must weigh this reduction with any increases in performance attributable to the HMO population. Furthermore, to take on managed care contracts the hospital must have a control structure in place to assure that excess levels of hospital inputs are not committed to the HMO patients. This may take the form of either monitoring or rationing the available inputs;. which method is most effective remains an open question.

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[47] Two part fee schedules include a fixed component and variable component with units delivered.

### *Further Research Questions*

#### Theoretical Extensions

The model in this thesis may fruitfully be expanded along a number of fronts. The first and potentially most valuable extension would be the inclusion of the form of the physician's contract chosen by the HMO along with the form of the hospital's contract chosen by the HMO. The analysis performed already shows the importance of the physician's objectives on the level of outputs delivered by the hospital as well as the corresponding level of capacity chosen by the hospital. If the physician was reimbursed on a capitated basis such that they derived no additional income or utility from the prescription of hospital inputs, the degree of divergence between the hospital and physician objectives might be reduced. In addition, the optimal level of monitoring and capacity reduction may change as well. It is also conceivable that when physicians are reimbursed on a capitated basis, that they may have an added incentive to substitute hospital inputs for their own thereby increasing the degree to which hospital inputs are supplied to the physician. The degree of monitoring or the form of the explicit constraints imposed on the physician by the HMO will also have a significant impact on the delivery of hospital inputs. As such the contract written with the physician will affect hospital behavior. In short, due to the presence of separate fee schedules and forms of reimbursement for physicians and hospitals the HMO is in a position to play one provider off the other. A theoretical model which addresses these tensions would be of value.

The current theoretical model while addressing the importance of both monitoring and capacity reductions as means of controlling the agency problem does not address which means is more efficient. If increased monitoring may be tailored to only the HMO patients while a reduction in the capacity level affects all patients unilaterally, monitoring may be more efficient. This is a question which should be addressed both theoretically and empirically.

### Empirical extensions

The current empirical model examined each adjustment by the hospital in isolation while it is likely that a hospital makes a number of such adjustments in any one period. Further the hospital may limit capacity as a substitute for reductions in the number of staff. If the hospital is employing capital and labor in an optimal fashion a reduction in the capital available may necessitate an increase or decrease in the amount of labor employed depending on the extent to which capital increases the marginal product of labor. A model which includes both dimensions simultaneously would be of value in understanding not only the marginal product of both factor inputs but also how these levels depend on the level of output produced.

The empirical analyses performed in this thesis do not account for the quality of the services produced. This may be an important determinant of HMO contracting with hospitals. In the appendix to chapter 3, a theoretical model is solved in which the hospital's demand is a function of quality. This characterization of quality as monotonically increasing function of the number of inputs delivered is weak. The change in the hospitals level of capacity and monitoring not only affect the form of the hospital's SRAC but also the level of quality delivered. Increased monitoring may not only decrease the level of services delivered but may also have the added benefit of increasing the quality of the service produced. In addition, it is unclear what impact a reduction in the level of capacity or capital will have on the quality of the service delivered. These questions are worthy of empirical examination in light of the sparse information on provider quality. If information on provider quality was widely available it might be possible to assume away any reductions in quality since demand could respond to diminished quality by seeking out another provider.

The theoretical model suggested that the hospital must change its production function to compete effectively for managed care patients. This change is moderated by the existing demand for a higher level of inputs by FFS patients. As a result, there may exist some threshold effect or nonlinearity in the response of hospitals to increasing HMO penetration. A 5% HMO share may not result in the hospital changing their service configuration while a 35% HMO share may result in a hospital retiring a significant portion of their existing capital as they adjust their production function to deliver a lower level of inputs. Knowledge of the necessary HMO penetration to effect a change in the hospital behavior is valuable information.

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